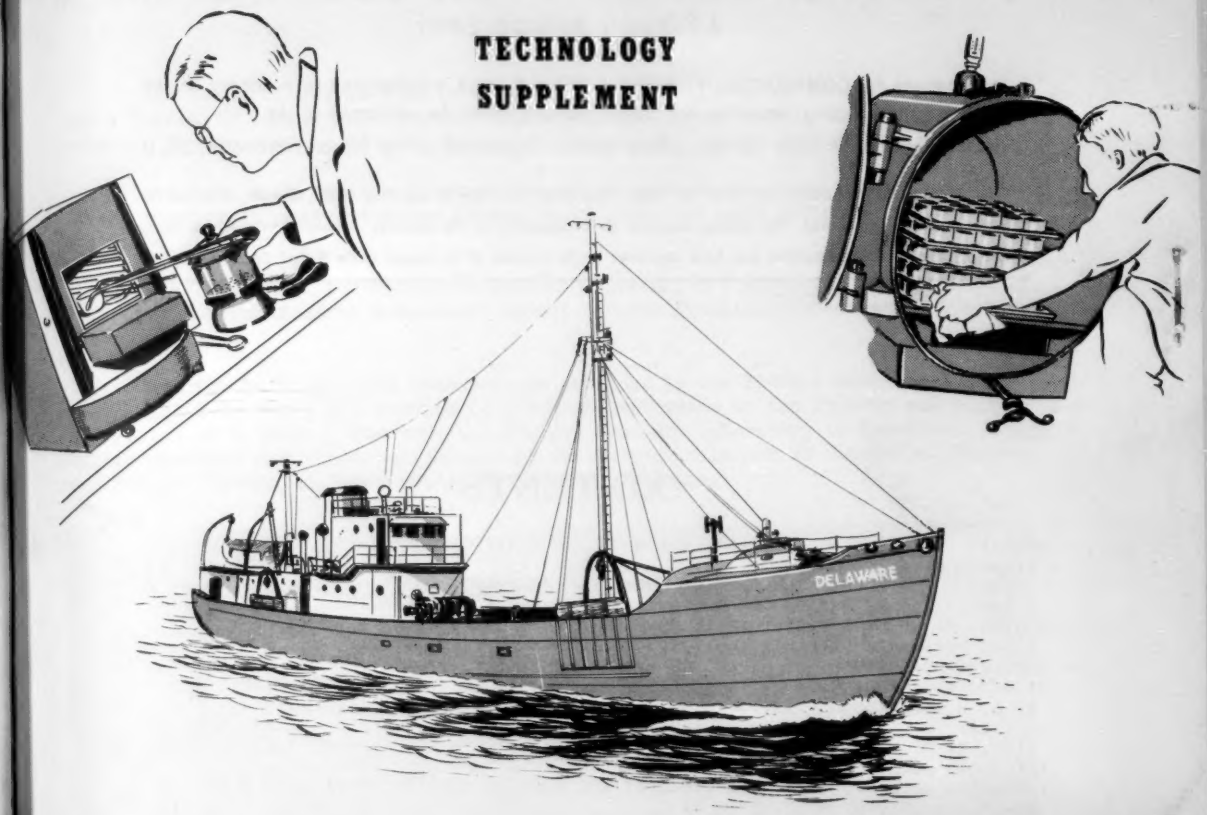
COMMERCIAL FISHERIES REVIEW



TECHNOLOGY SUPPLEMENT

Vol. 13, No. 11a **NOVEMBER 1951 - SUPPLEMENT**

FISH and WILDLIFE SERVICE
United States Department of the Interior
Washington, D.C.

UNITED STATES
DEPARTMENT OF THE INTERIOR
OSCAR L. CHAPMAN, Secretary

FISH AND WILDLIFE SERVICE
ALBERT M. DAY, Director

COMMERCIAL FISHERIES REVIEW

A REVIEW OF DEVELOPMENTS AND NEWS OF THE FISHERY INDUSTRIES
PREPARED IN THE BRANCH OF COMMERCIAL FISHERIES

A. W. Anderson, Editor
R. T. Whiteleather, Associate Editor
J. Pileggi, Assistant Editor

Applications for COMMERCIAL FISHERIES REVIEW, which is mailed free to members of the fishery industries and allied interests, should be addressed to the Director, Fish and Wildlife Service, United States Department of the Interior, Washington, 25, D.C.

The printing of this publication has been approved by the Director of the Bureau of the Budget, December 15, 1949

CONTENTS

COMMERCIAL FISHERIES REVIEW

November 1951 Washington 25, D.C. Vol.13,No.11a

PROGRAM OF THE TECHNOLOGICAL SECTION OF THE SERVICE'S BRANCH OF COMMERCIAL FISHERIES

INTRODUCTION

Field research and Service activities of the Technological Section of the Service's Branch of Commercial Fisheries are centered in four Service laboratories located in Boston, Mass.; College Park, Md.; Ketchikan, Alaska; and Seattle, Wash.

Three mobile or trailer laboratories are maintained for chemical or bacteriological studies in out-of-the-way places or in locations some distance from stationary field stations.

One experimental technological research trawler, M/V Delaware, was obtained on loan from another Federal Government agency for the freezing-fish-at-sea project and related studies.

Funds for technological research are provided by the Federal Government and must be used to carry out studies of greatest importance to the fishery and allied industries as a whole. However, the Fishery Products Laboratory in Ketchikan, Alaska, is operated and supported jointly by the Service's Branch of Commercial Fisheries and the Fisheries Experimental Commission of Alaska.

FISHERY TECHNOLOGICAL LABORATORY, 61 SUMNER STREET (LOCKWOOD BASIN), EAST BOSTON, MASS. BUILDING ON LEFT HOUSES LABORATORY (THIRD FLOOR) AND ADMINISTRATIVE OFFICES. BUILDING ON RIGHT HOUSES PILOT PLANT FOR FREEZING-FISH-AT-SEA STUDIES, COLD STORAGE ROOM, AND OFFICES FOR PILOT PLANT AND ENGINEERING PERSONNEL.

University and Industrial Fellowships are sponsored in all laboratories. Limited laboratory facilities are available by contract for University, State, or Industrial sponsored projects. Results of any such research becomes public property and is available to industry.

FISHERY PRODUCTS LABORATORY IN KETCHIKAN, ALASKA. OPERATED JOINTLY BY THE U.S. FISH AND WILDLIFE SERVICE AND THE FISHERIES EXPERIMENTAL COMMISSION OF ALASKA.

In order to develop the program for the Fiscal Year 1952, beginning July 1, 1951, and ending June 30, 1952, the Chiefs of the Service's laboratories met in Washington, D. C., the last week of June 1951. On June 27, 1951, members of the fishing and allied industries attended the conference and offered their comments, criticisms, and suggestions on the previous year's program and the proposed program for this fiscal year. The following program was developed after taking into consideration industry recommendations:

PART I - FISHERY TECHNOLOGICAL RESEARCH PROGRAM, 1951-52

NUTRITION

1. Investigation of the toughening of frozen blue-crab meat (continued project). There is little information of a definite character available to guide the crab-meat packers in proper techniques for the freezing preservation of their products. Attempts to hold crab meat in frozen storage have not been successful except for very short periods. The work to date has shown that one or more enzymes may probably be responsible, at least in part, for the short storage life and additional work is contemplated to identify these. (College Park)

2. Feeding studies with gums extracted from Irish moss (continued project). Gums are being extracted from Irish moss and derivatives of these could be used in many foods and pharmaceutical preparations. Very little applicable data are available on nutritive value and wholesomeness of these products. Such data are required by Federal and State Regulatory Officials before new products are permitted to be used. Data are also needed in order to indicate the best use of a natural resource growing in fairly limited areas. (College Park)

3. Chemical and physical properties of fish and shellfish proteins: (1) Relationship between protein and water (continued project). The effect of controlled grinding on the water-binding characteristics of fish proteins has been investigated. Further work will be carried out on the effect of temperature on the water-binding properties of fish and shellfish protein. This investigation is directed toward providing basic information which might lead toward a better understanding of the tough-

ening of fish and shellfish in cold storage, of the nature and control of drip, and of the chemical and physical changes in dried or dehydrated fish and fish meal. The work on shellfish will deal primarily with the protein of oysters from the Gulf of Mexico and the East and West Coasts. (Seattle)

4. Thiaminase content of certain species of fish used in feeding fur animals. Certain species of fish contain an enzyme known as thiaminase which is capable of destroying the vitamin thiamin. When fish containing thiaminase are fed to fur animals, the animals develop Chastek's paralysis unless such fish are specially treated, as by cooking. Efforts are being made to utilize certain fish waste as a fur-animal feed. Often the first question potential users of such fish waste ask is regarding the thiaminase content. Inadequate information is available on this subject particularly with respect to the thiaminase content of the waste as contrasted to the meat. It is proposed to analyze a few of the most important types of fish waste, such as salmon-cannery waste and fillet waste, from a few of the commercially-important species of the Pacific Northwest for thiaminase so that this information will be available to potential users of waste for fur-animal feeding. (Seattle)

REFRIGERATION

1. Freezing fish at sea, defrosting, filleting, and refreezing the fillets (continued project). The research vessel M/V Delaware, now converted for large-scale commercial testing of freezing round fish at sea, will be operated during the first part of the year on a semi-commercial scale to test, and if necessary, modify freezing equipment and to provide commercial-size samples for pilot-plant and laboratory research. These tests will serve to furnish information on:

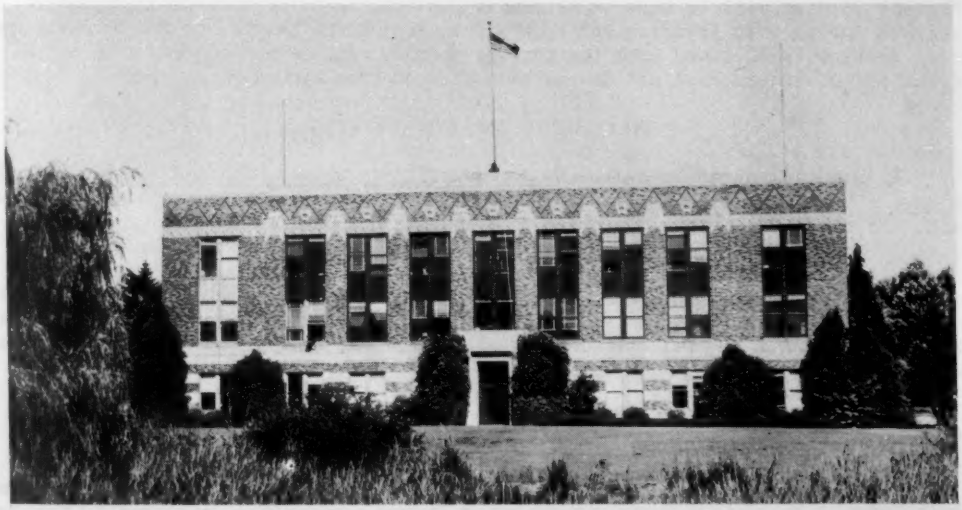
A. EFFECT OF PROLONGED STORAGE OF ROUND FROZEN FISH PRIOR TO DEFROSTING AND FILLETING;

B. RATIO OF BRINE TO FISH NECESSARY FOR OPTIMUM FREEZING;

C. ABSORPTION OF BRINE BY FISH;

D. FILLET AND VISCERA YIELD FROM ROUND FISH;

E. PREPARATION OF FISH STEAKS FROM ROUND FROZEN FISH;



FISHERY TECHNOLOGICAL LABORATORY IN SEATTLE, WASH., WHERE BOTH TECHNOLOGICAL AND BIOLOGICAL FISHERIES RESEARCH ARE CONDUCTED.

F. COMMERCIAL THAWING METHODS; AND
G. PALATABILITY OF FISH PRODUCTS PROCESSED FROM ROUND FROZEN FISH.

After information on the above points is secured, the vessel will be operated on a full commercial basis and an economic study will be made on operational and handling costs. (Boston)

2. Freezing and storing Alaska shrimp and Dungeness crab (continued project). Studies will be continued on use of improved cooking methods and packaging procedures for frozen shrimp and crab. The effect of lower storage temperatures will be tried. (Ketchikan)

3. Preparation of a manual on the refrigeration of fish (continued project). This project will be continued. Important chapters will be written first and will be issued separately as completed. Later, all chapters will be combined into a complete manual. (College Park)

4. Effect of the cycle of different storage conditions encountered in marketing upon the quality of frozen fish: (1) Effect of storing glazed whole fish in rooms provided with air circulation. In recent years, many cold storage plants have been constructed primarily for storage of packaged frozen foods in which refrigeration is supplied by means of unit coolers employing a blower. This results in rapid circulation of air which is not harmful to well packaged foods but rapidly removes the glaze from frozen whole fish which, if not reglazed at weekly intervals, soon become badly desiccated. This project will consist of studying the effect of protecting such whole fish against dehydration by storage in wooden boxes or cardboard cartons with and without protective paper liners in order to determine the simplest method of storing such fish without the necessity or frequent reglazing. (Seattle)

5. Study of cause of texture change of canned salmon prepared from frozen fish. Previous experimental work has shown that freezing salmon prior to canning causes adverse quality changes in the final product, especially with regard to texture. Further studies will be made to determine the importance of time and temperature changes during both freezing and heat processing on the texture of the product. Special problems associated with the texture changes will be considered, such as the formation of excess curd and decreased yields of free liquid in the canned product.

PROCESSING AND PRESERVATION

1. Development of specialty food products from Alaska fish and edible fish trimmings. One of the serious economic problems in Alaska is the seasonal aspect of the most important fisheries. In order to encourage the development of off-season industries, studies will be made of the preparation of specialty food products from fish and edible parts of fish waste which are not being fully utilized. The study will include the determination of processing recommendations and palatability tests of products. The edible parts of salmon waste, butter clams, and herring are to be investigated first. Fish will be pickled, smoked, or canned in order to develop the most suitable products for preparation in the off-season. (Ketchikan)

ANALYSIS AND COMPOSITION

1. Chemical composition of fish: (1) menhaden (continued project). There is considerable concern by members of the menhaden industry as to the future demand for the products now produced from these fish. Information will be obtained on the chemical composition of various products and tissues of menhaden. These data should permit an evaluation of possibilities for developing entirely new industrial or agricultural products. (College Park)

2. Cooperative work with the Association of Official Agricultural Chemists on the determination of oil in fish meal (continued project). The present accepted method for the determination of oil in fish meal is tedious and time-consuming. Studies will be directed toward developing a more rapid test and possibly toward improving the accuracy of the present method. (Seattle)

3. Composition and cold-storage life of fresh-water fish. Virtually nothing is known about the composition and cold-storage life of lake and river fish taken in the central portion of the United States. Because of the location of the Service's technological laboratories along the seaboard, technological work has been concentrated on marine fish, and work on fresh-water fish has been neglected. The 150,000,000 pounds of such fresh-water fish taken commercially each year make up a significant portion of the food fish production. On numerous occasions lack of information on these fish has been a serious handicap. It is planned to make a careful sampling of the more important commercial fresh-water fish and conduct analysis for moisture, oil, protein, and ash, and to make observations on the cold storage life of these species. (Seattle)

BYPRODUCTS

1. Vitamin content and nutritive value of fishery byproducts (continued project). The fishery byproducts and feed utilization industries are handicapped by the lack of information on the nutrient content of fishery products. Chemical microbiological, and biological assays will be conducted to determine the vitamin B_{12} and niacin content and possibly also of other growth factors in fish meals and condensed fish solubles. Also studies are contemplated to determine with chicks the comparative nutritive value of the protein of the different products. (Seattle and College Park)

2. Utilization of viscera from round (whole) fish frozen at sea. The research vessel M. V. Delaware while engaged in the freezing-fish-at-sea project will make

FISHERY TECHNOLOGICAL LABORATORY IN COLLEGE PARK, MD., LOCATED ON THE CAMPUS OF THE UNIVERSITY OF MARYLAND.

available large quantities of viscera for use in feedstuffs or pharmaceutical compounds. A cooperative study will be undertaken with fish meal and oil processors, pet food manufacturers, and pharmaceutical manufacturers to determine the most suitable uses for the viscera. (Boston)

3. Study of pharmaceutical and other industrial products from salmon eggs. Every year salmon canneries in Alaska discard millions of pounds of salmon eggs. Of the various portions from salmon cannery waste, the eggs offer the most promise for the production of pharmaceutical and other industrial products. Both the oil and protein fraction of the salmon eggs are to be investigated in order to determine those constituents which might be profitably extracted and marketed. (Ketchikan)

SANITATION AND BACTERIOLOGY

1. Industrial waste pollution study (continued project). This is a cooperative project with the Atlantic States Marine Fisheries Commission to determine the extent and effect of industrial wastes on the marine fisheries. The first phase of the study, namely, an inventory and analysis of prior pollution studies, is complete and reports are currently being prepared for distribution. The second phase of the study will cover the economic aspects of the effects of industrial wastes on the marine fisheries. (Boston)

REPORTS ARE TO BE COMPLETED ON THE FOLLOWING PROJECTS (Research work on these projects has recently been completed):

1. UTILIZATION OF SALMON CANNERY WASTE FOR HATCHERY FOOD. (SEATTLE)
2. CLAM PROCESSING METHODS AND CLAM TOXICITY SURVEY. (KETCHIKAN)
3. STUDY TO DETERMINE THE HEMOPOIETIC (BLOOD-PRODUCING) VALUE OF FISH. (COLLEGE PARK)
4. DETERMINATION OF FOOD VALUE OF FISHERY PRODUCTS AS PREPARED FOR SERVING. (COLLEGE PARK)
5. STUDIES ON METHODS OF HANDLING FROZEN SALMON FOR CANNING. (KETCHIKAN)
6. FREEZING PINK SALMON. (KETCHIKAN)
7. PALATABILITY AND COLD STORAGE LIFE OF VARIOUS SPECIES OF PACIFIC COAST ROCKFISHES. (SEATTLE)
8. CORRELATION OF BIOLOGICAL AND SPECTROPHOTOMETRIC METHODS FOR THE DETERMINATION OF VITAMIN A POTENCIES. (COLLEGE PARK AND SEATTLE)
9. UTILIZATION OF SALMON CANNERY WASTE FOR ANIMAL FOOD (COOPERATIVE TESTS WITH THE PETERSBURG, ALASKA, EXPERIMENTAL FUR FARM). (KETCHIKAN)
10. REVISION OF BOOKLET "ALASKA SEAFOOD RECIPES." (KETCHIKAN)

PART II - INFORMATION ON PROGRESS OF TECHNOLOGICAL PROJECTS

Current information regarding the progress on the various projects is presented in Commercial Fisheries Review (CFR) in the section "Research in Service Laboratories."

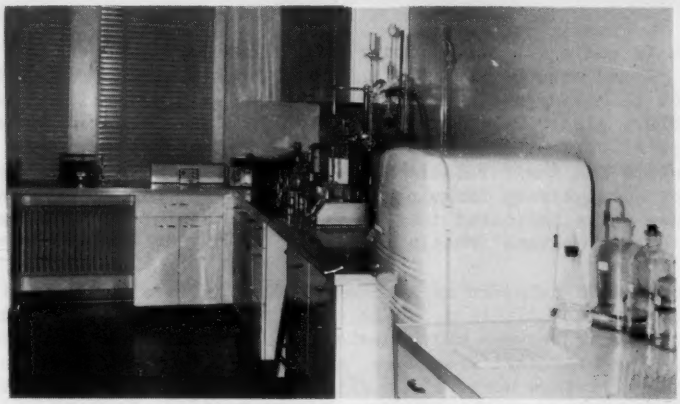
More detailed information on the projects may be obtained by the fishery and allied industries by writing directly to the Branch of Commercial Fisheries, Fish and Wildlife Service, Washington 25, D. C., or to the laboratories;[1/] or by consulting with members of the Technological Section. Phase or final reports on projects are usually

1/SEE INSIDE BACK COVER OF THIS ISSUE FOR ADDRESSES OF LABORATORIES.

published in Commercial Fisheries Review, as fishery leaflets (FL) or scientific reports, or in non-governmental scientific journals. Abstracts of these and other current information pertaining to commercial fisheries are available in Commercial Fisheries Abstracts (CFA).

CFR, CFA, FL, and most scientific reports are available free to members of the fishery and allied industries on request. Some of the special scientific reports are sold by the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

SECOND FLOOR OF KETCHIKAN LABORATORY ALMOST COMPLETED



A SECTION OF THE BACTERIOLOGICAL LABORATORY ON THE SECOND FLOOR OF THE KETCHIKAN FISHERY PRODUCTS LABORATORY.

During the past year, the second floor addition to the Ketchikan laboratory was completed: however, lack of funds precluded installation and equipment of all the various individual laboratory units. During this fiscal year, the bacteriology laboratory was completed using special funds appropriated by the Territory of Alaska through the Fisheries Experimental Commission. The bacteriological laboratory will provide facilities for the current project on the study of pharmaceutical and other industrial products from salmon eggs.

Besides the bacteriology unit, the second floor addition provides space for much-needed offices, biology laboratory, photographic darkroom, test kitchen, conference room, and storage. The test kitchen has already been in operation for some time. The home economics staff is currently engaged in completion of the material for the revised Alaska fish-recipe booklet.

A STUDY OF pH OF STRICTLY FRESH COMMERCIALLY-SHUCKED EASTERN OYSTERS

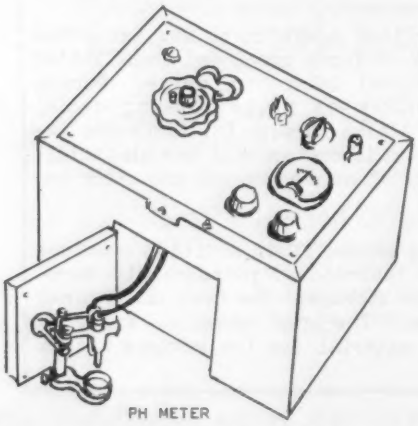
By S. R. Pottinger*

INTRODUCTION

The determination of pH of shucked oysters as a means of indicating the relative freshness of the product is relied upon to a considerable extent. State health departments, grocery store chains, the Armed Services, and others concerned with the inspection, distribution, and consumption of shucked oysters are becoming more and more dependent upon pH values to guide them in judging freshness and for use as a basis on which quality may be expressed, at least partly in objective terms rather than relying entirely on personal observations or opinions.

The idea is not a new one. Hunter and Linden (1923) reported a relationship between pH and odor of oysters; and later Hunter and Harrison (1928) suggested that pH measurements might prove valuable in determining quality of shucked oysters. Along with other work being done with shucked Eastern oysters at the Service's College Park, Maryland, Technological Laboratory in the early 1940's, pH values and their relation to the degree of freshness of oysters were determined for a relatively large number of samples of commercially-shucked oysters. These tests indicated that pH values are useful in following changes in freshness of the oysters (Pottinger 1948).

Some packers and shippers of shucked oysters believe, however, that pH is not a reliable enough indication of the quality of oysters. They claim that wide variations occur between pH values of individual oysters, and that low pH values, indicating decreased freshness, are often obtained with strictly fresh oysters. Such variations would obviously nullify the usefulness of the test.



PH METER

To obtain further data on pH of strictly fresh oysters, in general, and on individual oysters, in particular, and to determine the range of pH values, a series of determinations were begun by the College Park Laboratory in the winter of 1949-50. It was planned to continue the study the following oyster season, but because of a change in projects, the work has not progressed beyond that which was done the first season. This report is based on that work.

EXPERIMENTAL PROCEDURE

The pH determinations were made on strictly fresh shucked oysters at the time of preparation for packing. Practically all of the studies were made at one

* CHEMIST, FISHERY TECHNOLOGICAL LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U.S. FISH AND WILDLIFE SERVICE, COLLEGE PARK, MARYLAND. (NOW STATIONED AT THE TECHNOLOGICAL LABORATORY IN EAST BOSTON, MASS.)

shucking house in the Upper Chesapeake Bay area, so that at least a fairly complete picture of pH values of oysters from one area over most of the oyster season was obtained. Some tests were also made at Crisfield, Md., and Chincoteague, Va., during the latter part of the winter. Shell stock from Eastern Bay (Norfolk, Va., area) and from Tangier Sound (Virginia) was available for the tests at Crisfield.

Samples, on which the pH determinations were made, were obtained at the packing table, immediately after coming from the blowing tank and final skimming table. Samples were also brought to the Laboratory for further pH determinations after holding at ice temperature.

Determinations were made on individual oysters ground through a meat chopper; three oysters ground together; six oysters ground together; and on the oyster liquor. Oysters of two size designations, standards and selects, were used. The pH determinations were made with a Beckman, laboratory model G, pH meter.

Oysters from approximately 100 samples were examined at the plant in the Upper Chesapeake Bay area during the season. Only a few samples were examined at plants in other areas. The average pH values are given in table 1.

Table 1 - Average pH values of strictly fresh oysters from various areas

SAMPLE	SELECTS				STANDARDS	
	Upper Chesapeake Bay	Eastern Bay	Tangier Sound	Chincoteague	Upper Chesapeake Bay	Eastern Bay
	pH	pH	pH	pH	pH	pH
Single oyster	6.62	6.80	6.70	6.50	6.55	6.80
Three oysters*	6.62	6.84	6.68	6.52	6.55	6.79
Six oysters*	6.64	6.83	6.70	6.53	6.53	6.79
Liquor	6.82	6.98	6.97	6.56	6.76	6.97

* COMPOSITE SAMPLE.

For a given area and within a size designation, average pH values of the oysters have shown very little variation, whether taken singly, in groups of three, or in groups of six oysters. The range in pH of the ground fresh meats at the time of packing was quite narrow. For example, the variation in pH of the Upper Chesapeake Bay oysters was between 6.50 and 6.62 for the standards, and 6.58 and 6.68 for the selects. At the same time, the range in pH of the liquor was between 6.70 and 6.82 for standards, and 6.80 and 6.86 for selects. An equally narrow range was found with the oysters from the other areas.

A gradual drop in pH occurred during storage of the oysters in crushed ice. The values for individual oysters within a particular lot were found to stay within a rather narrow range for any given day. There was some variation in pH between lots as a whole, however. Some lots had an off-odor and were considered stale after being held about two weeks, while others were still in a good condition at this time. The difference in keeping quality and pH of two lots of Upper Chesapeake Bay oysters stored in crushed ice is shown in table 2.

At the time an off-odor was first noticeable, however, the pH of all lots was usually very nearly 5.80, with individual oysters occasionally having a pH value as high as 5.98 but seldom much below 5.80. As has been found in previous work with shucked oysters, the pH of the liquor was initially higher than that of the ground meats, but the two values approached each other as the holding period progressed.

Table 2 - pH values of two lots of Upper Chesapeake Bay oysters during storage in crushed ice

Lot	Sample	Number of days storage in crushed ice									
		Initial	1	3	4	5	8	10	15	18	22
		pH	pH	pH	pH	pH	pH	pH	pH	pH	pH
A	(Oysters	6.58	6.46	6.38	6.26	6.24	6.20	6.15	5.82*	5.66	—
	(Liquor	6.81	6.60	6.52	6.42	6.36	6.32	6.24	5.85*	5.62	—
B	(Oysters	6.55	6.50	6.42	6.38	6.32	6.26	6.19	6.15	6.14	5.80*
	(Liquor	6.71	6.65	6.60	6.52	6.50	6.44	6.38	6.30	6.24	5.78*

* OFF-ODOR (OYSTERS CONSIDERED STALE).

SUMMARY

In summary, the pH values for strictly fresh shucked Eastern oysters were found to fall within a rather narrow range. No unduly low values were found.

LITERATURE CITED

HUNTER, A. C., AND HARRISON, C. W.
1928. BACTERIOLOGY AND CHEMISTRY OF OYSTERS WITH SPECIAL REFERENCE TO REGULATORY CONTROL OF PRODUCTION, HANDLING AND SHIPMENT. U.S. DEPARTMENT OF AGRICULTURE. TECH. BULL. NO. 64.

HUNTER, A. C., AND LINDEN, B. A.
1923. AN INVESTIGATION OF OYSTER SPOILAGE. AMERICAN FOOD JOURNAL, VOL. 18, NO. 11 (NOVEMBER), PP. 538-40.

POTTINGER, S. R.
1948. SOME DATA ON PH AND FRESHNESS OF SHUCKED EASTERN OYSTERS. COMMERCIAL FISHERIES REVIEW, VOL. 10, NO. 9 (SEPTEMBER), PP. 1-3.

FISHERIES EXPERIMENTAL COMMISSION OF ALASKA HOLDS MEETING

Members of the Fisheries Experimental Commission of Alaska held their first meeting of the new fiscal year in Ketchikan during June to discuss the program of the technological laboratory for the next biennium. The Fishery Products Laboratory, Ketchikan, Alaska, is operated jointly by the Alaska Fisheries Experimental Commission and the U. S. Fish and Wildlife Service. Members of the Commission are: J. W. Mendenhall, Chairman; J. A. Dassow, Secretary; and Andrew Gunderson.

The original agreement between the Commission and the Service for cooperative work was executed in February 1940. The ultimate objectives are research and development towards advancement of the fisheries industries of Alaska. Besides the technological research studies, the Service employs a fishery marketing specialist who carries out educational and market development studies. Cooperative work is also carried out with the Agricultural Extension Service of the University of Alaska.

CHEMISTRY OF MENHADEN:

Report on Literature Study

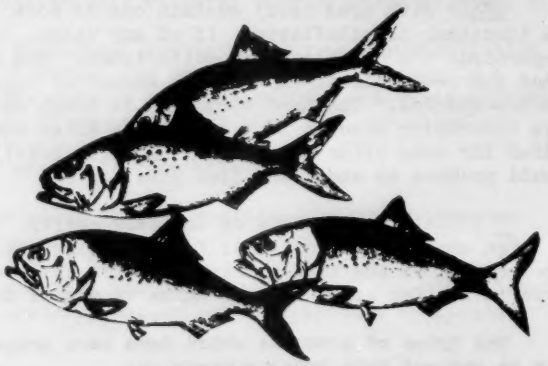
By C. F. Lee*

INTRODUCTION

A survey of the literature pertaining to menhaden, and to the non-food and byproduct use of fish in general, was undertaken with two objectives in mind: to provide a background for the selection of the particular phase of the chemistry of menhaden which would be the initial research project of this laboratory; and to stimulate interest of other laboratories or individuals in the study of some of the possible, and even not so probable, new uses for the menhaden.

The first objective was established by the fact that the very limited staff at the laboratory made a general assault on the problem impossible. The desirability of the second, in view of these limitations, is obvious. The more investigators in laboratories of all types - commercial, educational, or governmental - that become interested in the problems of the menhaden industry, the sooner some concrete results should be forthcoming.

The literature is replete with references on uses of fish byproducts which are specific to certain species in ways that virtually eliminate the menhaden from similar consideration. Examples are the use of fish skin for leather or the use of livers for vitamin oil. In many other cases, our present lack of knowledge of the menhaden does not permit the line of practicability to be drawn with any degree of certainty. In the discussion to follow, uses for menhaden are mentioned by analogy, based on little more evidence than that it, too, is a fish. Generally, an effort has been made to include mention of such factors as are now known for and against the use of menhaden for the purpose under discussion. It should be emphasized, however, that because of the paucity of information on the subject, these qualifications are not intended to be conclusive in either direction as to the ultimate practicality of any use considered for the menhaden.



MENHADEN

Among the sources inspected in the course of this survey were Chemical Abstracts, Industrial Arts Index, Agricultural Index, and microfilm 85171S of the chemical literature survey made in connection with the study of the "Industrial Utilization of Salmon Waste." In this report, an effort has been made to systematically summarize and discuss the literature but without mention of particular sources. The material has been divided into four sections. Possible uses of the component parts of the menhaden will be considered first, then possible new uses for the whole fish. Third, the literature concerning the present use for menhaden

*CHEMICAL ENGINEER, FISHERY TECHNOLOGICAL LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U.S. FISH AND WILDLIFE SERVICE, COLLEGE PARK, MARYLAND.

products - oil, meal, and solubles - has been considered, with a brief preview of future research on these products. Finally, a brief mention has been made of certain problems of the industry itself which would benefit by a research program.

POSSIBLE USES FOR COMPONENT PARTS OF MENHADEN

As far as the literature is concerned there is none on this subject specifically related to the menhaden and we do not have the information necessary to properly evaluate the applications by analogy that we are thus forced to resort to.

In this connection, it might be recalled that the menhaden (Brevoortia sp.), which includes 6 subspecies, is found only along portions of the Gulf Coast, the East Coast from northern Florida to Long Island, and off the Brazilian coast; while sea herring are to be found in almost all the colder waters of the Northern Hemisphere. This lack of any European or Asiatic representatives of Brevoortia is responsible, in the main, for the absence of experimentation with the unusual, less obvious uses for the menhaden. Shortages in these foreign areas have been an incentive to make the most of every resource and to search the bountiful sea for the products their lands could not provide.

The suggestion has been made that the possibilities of the menhaden should be considered from head to tail and backbone out to skin. Pursuit of this scheme leads to the head as our first object of interest.

HEAD: Fish eyes (cod) contain one or more flavins, of which one is said to be identical to riboflavin. If of any value, the eyes could be fairly easily separated, the capsule being quite tough. The menhaden has no teeth, nor is the head the reservoir of any unusual amount or type of oil, as is true of some marine species. The head structure is tough and horny, a characteristic noted in the laboratory when it is necessary to grind the raw fish. If the head was separated for some other purpose, it is quite possible that this horny head skeleton would produce an excellent fish glue.

VISCERA: The contents of the body cavity, or viscera, are a raw material for a large number of theoretically possible new and valuable products. It is also the portion of the fish concerning which there exists the absolute minimum of information for assessing the value of any of these possible uses.

The types of products which have been prepared from the viscera of any fish may be grouped into three categories:

1. VITAMIN OIL PRODUCTS. THESE ARE USUALLY PREPARED FROM THE LIVER, OCCASIONALLY THE WHOLE VISCERA IS USED. EITHER VITAMIN A OR D, OR BOTH, ARE FOUND IN SIGNIFICANT AMOUNTS IN THE LIVER OF CERTAIN SPECIES.

2. PRODUCTS FROM MILT OR ROE. IN SOME CASES, THE ROE IS USED FRESH (SHAD OR HERRING); IT MAY ALSO BE CANNED (ALEWIFE) AND, OCCASIONALLY, SMOKED. MILT, OF HERRING AND SALMON FOR EXAMPLE, IS KNOWN TO CONTAIN A FAIRLY SIMPLE PROTEIN MADE UP OF PROTAMINES AND HISTONES, AND ON HYDROLYSIS THESE YIELD RELATIVELY SIMPLE AMINO ACID MIXTURES. SALMON ROE, AND POSSIBLY OTHER ROES, HAS BEEN USED FOR FEEDING HATCHERY FISH AND HAS BEEN CANNED FOR BAIT. SALMON ROE ALSO CONTAINS AN OIL WITH A VERY HIGH NATURAL IODINE NUMBER, GREATER THAN 220.

3. PRODUCTS FROM OTHER MINOR ORGANS. ENZYMES HAVE BEEN PREPARED FROM THE WHOLE VISCERA OR, MORE COMMONLY, FROM THE PYLORIC CAECA OR STOMACH. THESE ENZYMES ARE MOSTLY PROTEOLYTIC; ALSO LIPASES ARE REPORTED PRESENT IN LOW CONCENTRATION, ESPECIALLY IN FAT FISH. CRUDE ENZYME PREPARATIONS HAVE BEEN USED CHIEFLY AS LEATHER BATES,

ALTHOUGH THERE IS ONE REPORT OF PREPARATION OF A PEPTONE FROM FISH FLESH, SUITABLE FOR BACTERIOLOGICAL MEDIA, BY ACTION OF VISCERAL ENZYMES FROM THE SAME SPECIES.

Insulin may be the only hormone actually prepared from fish, but the field is largely unexplored due to the small size of the organs in most fish and also to the difficulty in obtaining suitable material. Fish are caught under circumstances that make the immediate recovery of desired organs highly impractical, and by the time the fish are landed either they have been gutted or considerable decomposition has occurred in the body cavity. ACTH is the newest of the hormone drugs; and every possible source, including fish, will doubtless be explored. A news item, dated June 7, 1951, states that the Norwegians have developed a process for producing ACTH from whales, but these animals can hardly be compared with the fish under consideration. It indicates the trend, however.

Besides enzymes and hormones, other chemicals are known to be present, for example in the bile where taurine, and cholic and taurocholic acids have been found.

To go from the general to the specific and consider menhaden as a source of any of these products, we are, as already said, handicapped by a total lack of concrete information. In consideration of the first type of compounds we are led to conclude that the menhaden has a small liver of low oil and vitamin content by analogy with the herring, mackerel, and sardine. These are characteristics of small, oily-bodied fish none of which have ever yielded a valuable liver oil. Possibility for production of the fat-soluble vitamins from menhaden is about nil.

The menhaden is somewhat of a biological mystery as far as spawning habits are concerned. Although herring, alewives, and shad are commonly taken in a spawning condition in season, sizable catches of ripe menhaden are quite uncommon. The fish presumably spawn in winter, in deeper waters than they are normally caught. The scarcity of fish in spawning condition makes the available catch of little value for the production of materials from milt or roe.

As for products from the other minor organs, any definite conclusions regarding the possibilities of the menhaden should await results of future work under consideration. Without any desire to be unduly pessimistic, it should still be noted that the menhaden, in common with the herring, sardine, and other largely planktonic feeders, has a proportionately smaller body cavity than the predatory fish.

BONES: The menhaden bony structure is similar to that of shad or herring, the flesh being liberally laced with fine bones. One investigator has determined the availability to the rat of the calcium content of fish bones. He found the calcium in a highly available form equivalent to the calcium of milk. In addition to the available calcium and phosphorus, dried uncalcined bone contains a substantial amount of protein, approximately 30 percent, so that dried ground bone would be a valuable supplementary source of both protein and mineral elements.

MEAT: In considering the meat of the menhaden, the discussion in this section shall be limited to new or special products from the meat, saving the consideration of food and feed usages for the following section on whole fish. Most of the unusual uses to which the meat of fish has been put are dependent upon the meat protein. Uses for the oil fraction of the meat, which have been more extensively developed already, will be grouped under the heading of present products in the final section.

Fish proteins as a rule are readily hydrolyzed, perhaps with greater ease

than most of the vegetable proteins. Acids, alkalies, enzymes, or conditions of heat and pressure have been used for effecting protein hydrolysis. By variation in the type and concentration of reagent and in the temperature and time of reaction, a great variety of products of every degree of hydrolysis may be obtained.

In theory, at least, proteins can be completely hydrolyzed and the component amino acids isolated, but because fish body proteins are "complete" proteins (hence their high feeding value), the resulting amino acid mixture is too complex to make this procedure valuable as an amino acid source. Preparations of mixtures of amino acids, particularly from casein, have been used recently in medicine in cases where protein digestion is faulty because of operations on the alimentary tract or for numerous other causes. Fish proteins would be a "natural" for this type of product if certain difficulties arising from undesirable flavors and colors could be eliminated.

Isolation of certain of the amino acids may be possible by partial or selective hydrolysis in several steps. A great deal of work might be expended on one such single isolated phase of the chemistry of menhaden.

Most of the reports in the literature dealing with fish protein, other than straight analysis for constituent amino acids, have been concerned with various partially hydrolyzed mixtures. Such "protein" solutions can usually be precipitated by chemicals neutralizing the solubilizing agent. This principle is the basis of numerous fibers and fabrics that have been prepared from fish, especially in Germany. A somewhat similar procedure, with removal of inorganic salts and some of the simpler hydrolytic products, yields a so-called "synthetic egg white" which can be substituted, at least in part, for the natural product in some food products. This also was a European development. Even more mild treatment with alkali at relatively low temperatures removes easily hydrolyzed material and fats without dissolving the major part of the protein. The remaining protein is rather gelatinous and when washed and dried gives a food product similar to Scandinavian "lütefisk."

Still another type of protein product results from the action on the meat of fish of an aldehyde, such as formaldehyde, or other chemical agent to produce various types of plastics.

For all of the above protein products, the oil in menhaden flesh would be an undesirable impurity. While the presence of the oil would not prevent the use of menhaden in this manner, it would probably mean one or more additional processing steps and extra equipment not required when non-oily fish, such as cod, pollock, or shark, are used.

SKIN: The skin of menhaden does not appear to present a possibility of producing any products of value sufficient to warrant its separation. If removed in connection with some other product, the skins would probably yield a good fish glue. They are too small for use for the specialty leather products that have been prepared from some fish skins. The literature contains one report of "flavins" (not further identified) in the skin of some teleost fish, and another report, of Japanese origin, claims the existence of substances with "estrogenic" activity in the skin of "small fish." Evaluation of this and similar reports of Japanese origin is very difficult. A great deal depends on the interpretation of the translator, and species definition is frequently lacking.

SCALES: The scales of the menhaden are similar to herring scales, but do not separate from the skin with the same readiness. If a method of separation could be found, there would be numerous possibilities for the use of the "pearl essence"

substance with which they are coated. This material is already prepared from herring, sardines, and alewives. It is used in paints, lacquers, and various plastics to give an attractive sheen difficult to duplicate with any synthetic product. It is also used in the manufacture of artificial pearls.

The chief constituent of this pearly material has been identified as guanine, 2-amino 6-oxypurine, and one reference stated that a guanine isomer is also present. These substances are related to caffein, theobromine, and other of the purine-base alkaloids and could no doubt be used as a starting point for various syntheses for this type of compound. A newspaper account, dated June 6, 1951, mentioned the trial of a new drug for the treatment of certain cancers that delayed development of the tumors. The drug was identified as 8-azo-guanine, another member of the purine-base series. Nothing is known about the synthesis of this compound but guanine would appear to be the obvious raw material.

The cleaned scales consist of a horny substance that would be a good glue base and also are stated to be convertible to a plastic compound. Hydrolysis of the scale substance gives a stabilizer that is said to be used in the alkaline bicarbonate solution of foam-type fire extinguishers. Further study might point out other ways in which such stabilizer could be used. Cleaned scales may be a good source of cystine since on hydrolysis an amino acid mixture rich in this substance is obtained.

One entirely novel possibility was suggested by a staff member of the Beaufort, N. C., biological laboratory. While the scales are normally considered the external covering of the fish, there is actually another protective coating for the fish present in various degrees when fish are first removed from the water. This substance, commonly called fish slime, protects the fish from fungus and bacterial infection. So far as is known, the mechanism of this protection has not been studied, and the possibility that some fungostatic, fungucidal, or antibiotic substance may be present in the fish slime was suggested.

POSSIBLE NEW USES FOR THE WHOLE FISH

The foregoing section covers almost all present possibilities, some highly improbable, for products which might be prepared from various parts of the menhaden. There are in addition several ways besides oil and meal in which the whole or cleaned fish might be used. These uses, new only as far as the menhaden is concerned, are already absorbing large quantities of non-edible, or marginally-edible, fish and fish waste from fillet lines or canneries but are capable of absorbing even larger quantities in many cases.

One such use is the rapidly growing cat and dog food industry for which menhaden has already been used in small quantities. Another industry, similar except that it uses the fish fresh rather than canned, is fur farming, mostly fox and mink. Menhaden should be tested for the presence of the thiamin-destructive enzyme, thiaminase, before it is used raw in large quantities. Possibilities as a hatchery-food might also be considered. The very voluminous literature on this subject -- almost half the byproducts abstracts were concerned with it -- indicates that the dietary requirements for trout and other salmonoid fishes maintained in ponds are quite complex. Menhaden would seem to be about the only fish byproduct that has not been tried, in one combination or another, for hatchery food. The supply of menhaden is, however, rather far removed from most fur and fish farms. The former are located largely around the upper Great Lakes States, New England, and the Pacific Northwest; and the latter are most numerous in the Rocky Mountain and West Coast States.

There are uses of the menhaden described in a report prepared in 1875, when the industry was in its infancy, that suggest possible application to present-day practices. In those days, the commercial fishery for cod, halibut, pollock, and flat fish was entirely a bait fishery, and menhaden was considered the best bait fish available, several hundred thousand pounds yearly being used for this purpose. Whole menhaden were also ground and used as a chum bait in seining mackerel. The line trawler has just about disappeared from the scene, but chumming mackerel might be revived with a resulting increase in catch and a market for bait in the field of sport fishing might be developed. The worm industry that has developed recently in Maine and Massachusetts is an example of the possibilities that exist in this direction.

Another use for menhaden in the 1870's, now discarded almost entirely and perhaps unwarrantedly, was for human food. It seems strange, but menhaden were once considered very good eating when strictly fresh-caught, better than early-run shad or small striped bass. This was at a time when bluefish and trout were extremely plentiful in the same area. The large fat fish were preferred and were utilized pan-fried, salted, canned in oil like sardines, or put up in vinegar and spice like herring. Of course, revival of interest in menhaden as a food fish would be counter to a prejudice built up over many years, and label laws as to identity would not permit much leeway as to nonprejudicial naming of any product. Many people away from the East Coast may not have this depressing association, however. Some effort in the direction of developing food usage might be justified.

USES FOR PRESENT PRODUCTS

The discussion in the preceding sections is based for the most part on literature references to uses of products or byproducts of fish other than the menhaden, and the probable explanation of this situation was considered briefly. There is a considerable amount of literature on the menhaden; specifically relating to meal,

MENHADEN BEING CONVEYED ON BELT SYSTEM FROM THE HOLD OF THE VESSEL TO THE COOKERS.

oil, and solubles, in that order of abundance. Since our present concern is with new developments and new products, the literature, much of it ancient history due to the rapid developments in the field of nutrition, will be considered only briefly.

MEAL: When menhaden meal was first proposed as a feed ingredient, its contents of vitamin D, and to a much less extent vitamin A, were important talking points. Between 1930 and 1945 the meal was shown to contain relatively large amounts of riboflavin, choline, niacin, and pantothenic acid. Of course, it was considered a good protein source also, but the real spur towards full appreciation of its value as a protein supplement was the development of microbiological tests for many of the amino acids. With these tools, a comparative study of the amino acid ratios in the many vegetable protein sources and fish meals was feasible.

The latest, and perhaps the most important discovery to date, was the outcome of evidence that something more than just optimum balance of amino acids was contributed by fish meal, along with the natural "animal" protein, to the diet of chicks and rats. This so-called "animal protein factor," or APF, was soon concentrated and, in a surprisingly short time, a red substance known as vitamin B_{12} was isolated. The most recent development is the conviction of some investigators that in addition to vitamin B_{12} at least one (perhaps more) growth factor is contained in fish meal and in a few other natural protein or vitamin sources.

Menhaden meal has been used in much of the research on these various growth factors. However, the generic term "fish meal" is frequently used. For all practical purposes this nonspecific grouping as fish meals is not undesirable. Differences between kinds of meals -- menhaden, herring, or pilchard -- no doubt exist, but the accuracy of the various assay methods is insufficient, and the study of the influence of seasonal and regional factors and production methods has not reached the point where these differences can be clearly defined.

Further research on menhaden meal will probably be directed toward the clarification of the effect of some of these variables on meals, particularly in regard to protein quality, content of vitamin B_{12} and B_{13}, and other factors as yet unidentified.

Much remains to be done in the improvement of assay methods for the new growth factors. With suitable assay methods of not too great complexity, an interesting research problem would be the concentration of these new factors from menhaden meal or solubles; and some study of their properties might be possible also.

OILS: Reports of research on menhaden oil are somewhat less numerous than for the meals. There are three or four reports concerned with separation and identification of the fatty acids or glycerides present in menhaden oil, all indicating extreme complexity of the original glyceride structure. Fatty acids composed of from 16 to 24 carbon atoms are present, and the amount of unsaturation ranges from zero to six or more double bonds for each carbon group. The glycerides are composed, in the great majority of cases, of mixed fatty acids rather than being single acid tri-glycerides, so there is an extremely large number of isomeric glycerides possible.

The more saturated glycerides are removed in cold pressing, and the resulting oil is more reactive chemically. Double bonds can be shifted to conjugated positions in the molecule by treatment with alkali under certain conditions; and any desired degree of hydrogenation, catalytic splitting of the carbon chain, sulfation, polymerization or heat-bodying and blowing, are only a few of the presently-used or possible reactions of the cold-pressed oil. The resulting products are already

used in a very wide variety of ways. Paints, linoleums, inks, rubber, lubricants, detergents, and many others could be listed with new uses constantly being discovered for the more recently developed compounds prepared from the oil.

Future research on the oils might be carried out on the saturated fraction. This portion of the oil, as removed in the cold-pressing process, amounts to approximately 30 percent of the crude oil. In the past it has been used largely as a cheap soap stock. Some has been hydrogenated and deodorized for use as an edible fat, and a small amount is purified and used in pharmaceuticals, such as creams, lotions, and similar products. It is quite possible that further study of the constituent fatty acids and unsaponifiable matter present might lead to the development of more valuable products from this portion of the oils. Guanine, for example, is in all probability present in small quantities, derived from the scales during the cooking and pressing of the fish. As indicated in the earlier section concerning scales, this material might be the starting point for many valuable derivatives if methods for separation from the oil could be developed.

Another phase of oil chemistry requiring further research is the development of methods for the separation on a commercial or industrial scale of oil fractions having relatively narrow ranges of unsaturation. The cold-pressing process gives a very crude separation, the press cake containing about 50 percent of liquid oil. Various solvent fractionation procedures have been developed which give much sharper separations; but these involve low temperature operations, in the range of minus 10° C. to minus 60° C., and the use of inflammable and volatile solvents, such as acetone. The development of a method of separation using cheaper or less hazardous chemicals in a higher temperature range would be a very valuable contribution towards the further development of menhaden oil products.

SOLUBLES: Research on condensed fish solubles has been relatively limited. It has been shown, in general, that valuable growth factors that are present in the meal are present in greater concentration in the solubles. It has usually been assumed also that the protein portion of the solubles was equally as effective as fish meal for supplementing vegetable protein, although recent research tends to disprove this theory.

The recent rapid increase in the number of stickwater recovery units has resulted in a virtual glut in the solubles market, so that future research will probably be directed toward methods for retaining or returning the "solubles" fraction to the finished meal. Operations of this type are used in Norway, and have been reported in use in this country to a limited extent. In the meantime, fish solubles might offer a source superior to fish meal for the concentration and study of vitamin B_{13} and other still unidentified growth factors.

FURTHER RESEARCH DEVELOPMENTS IN THE MENHADEN INDUSTRY

There are several phases of the industry requiring additional study of a directly practical as well as a research nature. One of these pertains to the preservation of the raw fish on the boats before reaching port. This has become a problem of great importance, following the extraordinarily rapid development of the Gulf Coast menhaden fishery. This is a warm-weather fishery, extending from approximately May to September, and when longer trips to the grounds are necessary some operators find the fish arriving at the plants in a virtually liquid state. This results in many difficulties in handling during unloading, cooking, and pressing. Of even greater importance is the fact that soft fish lead to high solids in the stickwater and low oil recovery. The losses resulting from these factors may well approach one-half million dollars annually. The Norwegians have

reported work on the preservation of herring when immediate processing to meal is not practicable, but the problem in that country is hardly comparable. The periods of time involved are much longer, but normal air and water temperature are much lower than on the Gulf Coast. Sodium nitrite and formic acid have been found the most effective of the numerous chemicals and combinations of chemicals tried in Norwegian operations. However, there is no assurance that either chemical would be satisfactory under the conditions found on the Gulf Coast. A study of preservatives to be of practical value would almost certainly require field operations in the area involved because of the impossibility of reproducing boat-hold conditions in the laboratory.

Another practical research problem, also essentially a field operation, would be a more generalized extension of the preceding problem. This would be an over-all study of plant operations to determine losses, cause of losses, and methods of minimizing or preventing losses. This is a general problem for the whole industry, and is becoming more important as falling prices for oil and meal are rapidly reducing the margin of profit in menhaden plant operation. This project is in a sense an extension and modernization of the work carried out by the Bureau of Fisheries in 1928-30. This original work was so far ahead of the stage of technological development of the industry of that time that it was not generally accepted. There is every reason to believe that the industry would be far more receptive to a modern revised report of this nature, however, and quite valuable results might accrue from such a program.

SUMMARY

This report has not attempted to point out any certain phase of research on the chemistry of menhaden as the one and only future program. In the discussion of many of the projects, opinions have been expressed as to their desirability or otherwise. Some are repetitions of opinions voiced by the numerous plant owners and supervisors whom it has been the author's pleasure to interview in the past six months; others are entirely the opinion of the author. In neither case should undue weight be given to this discussion of the project. Approval has been given a program of research more than sufficient to occupy a force of several chemists for many years. The problem at hand is the selection of the most urgent or most promising of the projects.

CYTOLOGICAL STUDIES ON LACTOBACILLUS LEICHMANNII IN THE ASSAY OF VITAMIN B_{12}

By Sigurdur H. Petursson*

ABSTRACT

IN THE MICROBIOLOGICAL ASSAY OF VITAMIN B_{12} WITH LACTOBACILLUS LEICHMANNII, THE VITAMIN HAS A SIGNIFICANT INFLUENCE ON THE LENGTH OF THE CELLS. IN THE LOWER CONCENTRATIONS OF THE VITAMIN, THE CELLS TEND TO GROW LONGER AND THE DIVISION OF THE CELLS IS RESTRICTED. FORMATION OF VOLUTIN GRANULES IS ALSO DISTURBED.

INTRODUCTION

In the microbiological assay of vitamin B_{12}, the response of Lactobacillus leichmannii to different concentrations of the vitamin can be estimated either by the turbidity of the culture or by the amount of acid produced. In high concentrations of the vitamin the metabolism of the cells is normal, but in very low concentrations the growth is poor and the acid production is near zero.

It was desired to know whether these differences in metabolism could be demonstrated in the bacterial cells themselves. A preliminary microscopical investigation showed that the length of the cells varied in different concentrations of the vitamin. A comparison was then made of the variation in cell length with the turbidity of the broth culture and the amount of acid produced, both in standard tubes and in tubes containing samples. The results obtained are reported here.

METHODS

The medium used for the assay of vitamin B_{12} was modified from that recommended by Hoffman et al. (1949), and its composition is given in Table 1. The strain of bacteria employed was Lactobacillus leichmannii 313 (ATCC 7830). The standard was run at a concentration that varied from 0.005 to 0.8 millimicrograms of crystalline vitamin B_{12} per tube. Microscopic preparations were made from the tubes after incubation at 37° C. for three days and just prior to titration. In other experiments, microscopic observations and titrations were carried out after incubation periods of one and two days.

The slide films used for measuring the size of the cells were stained with methylene blue. Twenty-five cells were measured on each slide. To exclude subjective selection, every cell found in a given field was measured. When the number of cells in a single field was less than 25, a second or third field was observed to bring the total cells to this number. When the field was crowded, all cells occurring in a 25-cell portion of the field were measured. For the microphotography, the slides were fixed in Bouin's solution and were stained with crystal violet (method of Robinow).

* ECA FELLOWSHIP STUDENT, FISHERY TECHNOLOGICAL LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U.S. FISH AND WILDLIFE SERVICE, SEATTLE, WASHINGTON; PERMANENT ADDRESS: UNIVERSITY RESEARCH INSTITUTE, REYKJAVIK, ICELAND.

RESULTS

Microscopic observations on the bacteria in the standard tubes were made repeatedly and always gave the same results. That is, in the highest concentration of vitamin B_{12}, the rods were of normal length; but, as the concentration of the vitamin decreased, the length of the rods increased. Filaments without septa, 100 to 200 microns in length, were regularly found at the lowest concentrations (0.005 and 0.02 millimicrograms vitamin B_{12} per tube). This inverse correlation of the length of the cells with the concentration of the vitamin and, accordingly, with the final acidity in the medium was so regular that the results of the titrations could be predicted from the length of the cells. Data from a typical experiment in which microscopic observations and titrations were carried out after one, two, and three days are given in Table 2 (see also Figures 1 to 5). Although most of the cells at the lower concentrations of vitamin B_{12} were of long form, as can be seen from Figures 4 and 5, some short cells, 2 to 4 microns in length, were also found. The width of the cells was nearly constant but, except in length and curvature, no variations in the form of the cells could be seen.

Table 1 - Composition of Double-Strength Basal Medium[1/]

Ingredient	Grams
Glucose	40.0
Sodium citrate	20.0
Sodium acetate, anhydrous	20.0
Casein - acid hydrolyzed	10.0
K_2HPO_4	6.0
KH_2PO_4	6.0
$MgSO_4.7H_2O$	7.0
$MnSO_4.4H_2O$	1.5
$FeSO_4.7H_2O$	0.42
Asparagine	0.2
DL-tryptophane	0.2
L-cystine	0.4
Ascorbic acid	2.0
	Milliliters
Tween 80	2.0
Distilled water	to 1,000
	Milligrams
Adenine sulfate	20.0
Guanine hydrochloride	20.0
Uracil	20.0
Xanthine	20.0
Riboflavin	2.0
Niacin	2.0
Thiamine	2.0
Calcium pantothenate	2.0
p-Aminobenzoic acid	0.08
Pyridoxine	4.0
Pyridoxal	4.0
Pyridoxamine	0.8
Biotin	0.2
Folic acid	0.4

1/ pH IS ADJUSTED TO 5.5.

Observations were made on the length of the bacterial cells in the assay tubes from several samples of fishery products. The samples were fish, fish meal, and stickwater. The length of the cells varied in the same manner as in the standard tubes. That is, at the higher dilutions of the sample, with resulting lower concentrations of vitamin B_{12}, the cells grew longer.

In a mixture of beef liver, hog liver, and salmon viscera that had been autoclaved with concentrated NaOH to destroy the vitamin B_{12}, a slight vitamin B_{12}-like activity was still demonstrated in the microbiological assay. Such activity is usually attributed to thymidine (Wright et al., 1948) or other desoxyribosides. In this particular assay a correlation was found between acid production and cell length. At the higher dilutions of the sample, the activity was lower and the cells were longer.

The appearance of the volutin granules was influenced by the concentration of the vitamin. At the higher concentrations, several spherical granules made visible by methylene-blue staining were found in every cell. In the long cells formed at the lower concentrations of the vitamin, no regular granules could be demonstrated in this way. However, there were often two or three broad belts in the cell that stained darker than the protoplasm. These belts were usually several times broader than the diameter of

Figures 1 to 5 are Microphotographs of the Organism Lactobacillus leichmannii Grown in Media Containing Different Concentrations of Vitamin B_{12}

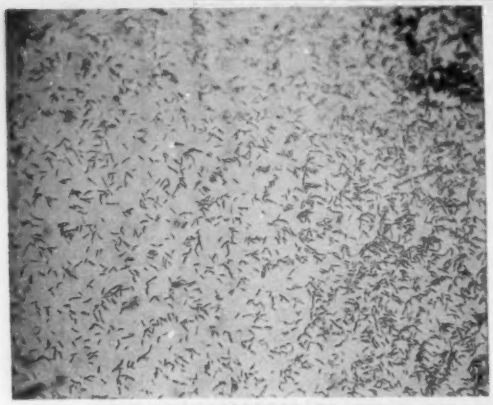


FIG. 1 - 0.8 MILLIMICROGRAMS OF VITAMIN B_{12} PER TUBE.

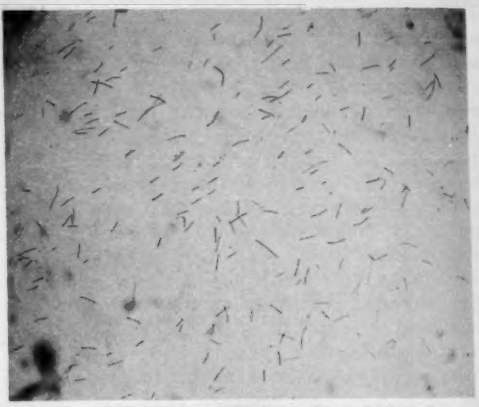


FIG. 2 - 0.2 MILLIMICROGRAMS OF VITAMIN B_{12} PER TUBE.

FIG. 3 - 0.08 MILLIMICROGRAMS OF VITAMIN B_{12} PER TUBE.

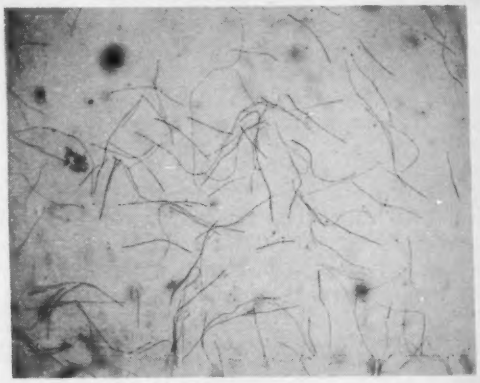


FIG. 4 - 0.02 MILLIMICROGRAMS OF VITAMIN B_{12} PER TUBE.

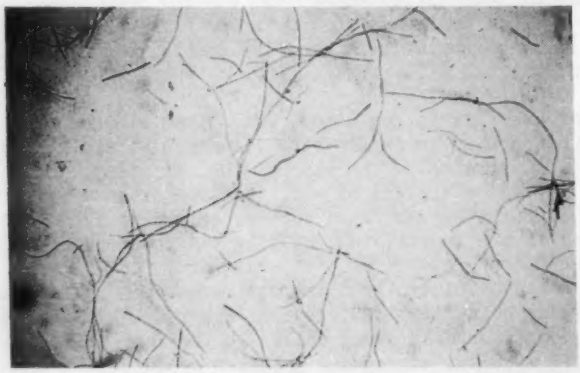


FIG. 5 - 0.005 MILLIMICROGRAMS OF VITAMIN B_{12} PER TUBE.

Figures 6 and 7 are Electron Micrographs of Lactobacillus leichmannii Grown in Media Containing Different Concentrations of Vitamin B_{12} and Show the Structure of the Individual Cells

FIG. 6 - 0.8 MILLIMICROGRAMS OF B_{12} PER TUBE. 18,500 X.

FIG. 7 - 0.005 MILLIMICROGRAMS OF B_{12} PER TUBE. 16,000 X.

Table 2 - Data on Growth of Lactobacillus leichmannii at Different Concentrations of Vitamin B_{12}

Incubation Period	Quantity of Vitamin B_{12} Per Tube	Growth Turbidity[1]	pH	Acidity Titration[2]	Length of the Cells		
					Minimum	Maximum	Average
Hours	Millimicrograms			Milliliters	Microns	Microns	Microns
20	0.8	✓ ✓	5.1	1.4	2	5	3.0
	0.2	✓ ✓	5.1	1.4	2.5	5	3.8
	0.08	✓	5.35	0.5	4	9.5	5.7
	0.02	-					
	0.005	-					
44	0.8	✓ ✓ ✓	4.55	5.4	4	8	6.1
	0.2	✓ ✓ ✓	4.6	5.2	2.5	18	10.8
	0.08	✓ ✓	4.7	4.0	7	40	19.2
	0.02	✓	5.0	2.0	2.5	110	29.2
	0.005	-					
68	0.8	✓ ✓ ✓	4.2	9.1	2.5	11	5.6
	0.2	✓ ✓ ✓	4.25	7.7	4	19	11.6
	0.08	✓ ✓ ✓	4.4	6.8	5.5	40	20.6
	0.02	✓ ✓	4.7	3.4	4	110	35.0
	0.005	✓	5.2	0.9	2.5	190	55.0

1/ ✓ INDICATES GROWTH OF THE ORGANISM. GREATER GROWTH TURBIDITY SHOWN BY INCREASE IN NUMBER OF ✓ MARKS. - INDICATES NO GROWTH.
2/ML 0.1-N NaOH REQUIRED TO TITRATE TO pH 5.5.

the rod. Structures corresponding to granules and belts can be distinguished in the electron micrographs, Figures 6 and 7.

Table 3 - Data on Growth of Lactobacillus leichmannii in Diluted Media Containing a Constant Amount of Vitamin B_{12} (0.4 Millimicrograms per 8-Milliliters of Diluted Medium)

Incubation Period	Amount of Double-Strength Medium	Amount of Water	Growth Turbidity[1]	pH of Control Tubes[2]	pH of Sample Tubes	Acidity Titration[3]	Length of the Cells		
							Minimum	Maximum	Average
Hours	Milliliter	Milliliter				Milliliter	Microns	Microns	Microns
20	4	4[4]	ƒ ƒ ƒ		5.05	1.6	4	8	5.5
	2	6	ƒ ƒ		4.85	1.6	3	8	5.7
	1	7	ƒ		4.9	0.6	3	9.5	5.4
	0.5	7.5	(ƒ)		5.2	0.2	4	16.5	6.4
44	4	4	ƒ ƒ ƒ		4.4	6.2	3	9.5	6.4
	2	6	ƒ ƒ		4.4	3.5	4	9.5	5.7
	1	7	ƒ		4.4	1.8	3	8	4.8
	0.5	7.5	(ƒ)		5.0	0.4	3	13.5	6.4
68	4	4	ƒ ƒ ƒ	5.5	4.3	7.6	3	10.5	6.8
	2	6	ƒ ƒ	5.6	4.3	3.6	2.5	10.5	6.7
	1	7	ƒ	5.7	4.4	1.8	2.5	8	5.9
	0.5	7.5	-	5.8	5.0	0.2	-	-	-

1/ ƒ INDICATES GROWTH OF THE ORGANISM. GREATER GROWTH TURBIDITY SHOWN BY INCREASE IN NUMBER OF ƒ MARKS. - INDICATES NO GROWTH.
2/ NOT INOCULATED.
3/ ML 0.1-N NaOH REQUIRED TO TITRATE TO pH 5.5.
4/ THE USUAL DILUTION.

Inasmuch as it was possible that the increase in the length of the cells always occurred when growth was poor and was not necessarily related to vitamin B_{12} concentrations, measures were taken to diminish the growth rate while keeping the concentration of vitamin B_{12} constant. For this purpose the medium was diluted in the first experiment with distilled water and in the second experiment with salt solution. The dilution of the medium with the salt solution was made to avoid excessive change in buffer action and in osmotic pressure. The same buffer salts were used as in the regular medium and in the same concentration. Thus the concentration of the buffer salts was the same in all the tubes. The concentration of the vitamin was maintained at 0.4 millimicrograms per tube in both experiments.

Table 4 - Data on Growth of Lactobacillus leichmannii in Diluted Media Containing a Constant Amount of the Buffer Salts and of Vitamin B_{12} (0.4 Millimicrograms per 8 Milliliters of Dilute Medium[1])

Amount of Double-Strength Medium	Amount of Salt Solution	Amount of Water	Growth Turbidity[2]	pH of Control Tubes[3]	pH of Sample Tubes	Acidity Titration[4]	Length of the Cells		
							Minimum	Maximum	Average
Milliliters	Milliliters	Milliliters				Milliliters	Microns	Microns	Microns
4	0	4[2]	ƒ ƒ ƒ	5.5	4.5	7.7	4.5	15	8.7
2	2	4	ƒ ƒ	6.0	5.0	2.7	5	15	10.5
1	3	4	ƒ	6.3	5.5		8	55	28.0
0.5	3.5	4	(ƒ)	6.5	6.1		4.5	45	19.1

1/ INCUBATION PERIOD WAS 68 HOURS.
2/ ƒ INDICATES GROWTH OF ORGANISM. GREATER GROWTH TURBIDITY SHOWN BY INCREASE IN NUMBER OF ƒ MARKS. - INDICATES NO GROWTH.
3/ NOT INOCULATED.
4/ ML 0.1-N NaOH REQUIRED TO TITRATE TO pH 5.5.

Dilution of the medium with distilled water did not appreciably affect cell length (Table 3). The length was nearly the same as would be expected from the concentration of the vitamin, even where poor growth was obtained.

The results of the experiment in which salt solution was used differed from those obtained by dilution of the medium with distilled water. The length of the cells increased greatly in the higher dilutions where the growth was also poor (Table 4).

Addition of 0.0025 to 0.1 millimicrograms of cobalt in the form of $CoCl_2$ to the tubes in the standard having the lowest concentration of vitamin B_{12} (0.005 and 0.02 millimicrograms) did not influence the length of the cells.

DISCUSSION AND SUMMARY

In the microbiological assay of vitamin B_{12} with Lactobacillus leichmannii, the vitamin has a significant influence on the length of the cells. In the lower con-

centrations of the vitamin, the cells tend to grow longer and the division of the cells is restricted. Formation of the volutin granules is also disturbed. By diluting all the nutrients in the medium except vitamin B_{12}, growth rate of the cells was diminished, but the influence on the cell length was insignificant. Therefore, increased length of the cell is not a characteristic of poor growth. The increase in cell length resulting from dilution of all the ingredients in the medium, except the buffer salts and the vitamin B_{12}, might be explained as an inhibition of the activity of the vitamin.

Substances that are able to replace the vitamin B_{12} in microbiological tests appear to have the same influence on the cell length as the vitamin itself.

It is interesting to note that in cases of pernicious anemia, in which there is a deficiency of vitamin B_{12}, the division of the earliest forms of the red blood cells in the bone marrow is restricted, causing them to grow larger than normal. Perhaps, vitamin B_{12} affects the division of the red blood cells in the same way as it does the cells of Lactobacillus leichmannii.

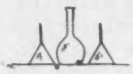
ACKNOWLEDGMENT

Acknowledgment is made of the advice and the assistance of Professor E. Ordal, Mrs. H. Agar, and Miss M. Loebeck of the University of Washington, and of Miss Neva Karrick of the U.S. Fish and Wildlife Service.

LITERATURE CITED

HOFFMAN, C. E.; STOKSTAD, E. L. R.; HUCHING, B. L.; DORNBUSH, A. C.; AND JUKES, THOMAS H.
1949. THE MICROBIOLOGICAL ASSAY OF VITAMIN B_{12} WITH LACTOBACILLUS LEICHMANNII. JOURNAL OF BIOLOGICAL CHEMISTRY, VOL. 181, PP. 635-44.

WRIGHT, L. D.; SKEGGS, H. R.; AND HUFF, J. W.
1948. THE ABILITY OF THYMIDINE TO REPLACE VITAMIN B_{12} AS A GROWTH FACTOR FOR CERTAIN LACTOBACILLI. JOURNAL OF BIOLOGICAL CHEMISTRY, VOL. 175, PP. 475-6.



CURING OF FISHERY PRODUCTS

Fish curing is an important method of preservation in the fishing industry and in the trade generally, but information on the principles involved in the salting and smoking of fish commercially is widely scattered. This report is a reference handbook on the problems of fish curing. It includes information from recent technical studies of the principles on which fish curing is based, discusses improvements in methods and equipment, and describes the standard methods.

By Norman D. Jarvis, Research Report No. 18. Fish and Wildlife Service, Washington 25, D. C. (1950), 270 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 75 cents.

UTILIZATION OF ALASKA SALMON CANNERY WASTE AS A SOURCE OF FEED FOR HATCHERY FISH

By R. G. Landgraf, Jr.,* D. T. Miyauchi,** and M. E. Stansby***

ABSTRACT

COMMERCIAL-SCALE TEST SHIPMENTS WERE MADE OF SALMON TRIMMINGS FROM A CANNERY IN PETERSBURG, ALASKA, TO THE STATE OF WASHINGTON. THIS WASTE MATERIAL, VISCERA AND EGGS, ORDINARILY DISCARDED BY THE CANNERIES, WILL BE USED IN FEDERAL FISH HATCHERIES AS AN EXCELLENT SOURCE OF PROTEIN AND VITAMINS IN THE DIET OF HATCHERY FISH. THE VISCERA WERE PACKED IN 0.002-INCH THICK POLYETHYLENE TRANSPARENT BAGS (19 INCHES WIDE BY 42 INCHES LONG) PLACED INSIDE A BURLAP BAG (18 INCHES WIDE BY 36 INCHES LONG). THE MATERIAL WAS FROZEN AND SHIPPED TO WASHINGTON BY REFRIGERATED VESSEL. ALTHOUGH THE BAGS OF MATERIAL WERE ROUGHLY HANDLED DURING ALL PHASES OF THE OPERATIONS AND DURING TRANSIT, OVER 100,000 POUNDS OF THE FROZEN MATERIAL WERE DELIVERED TO FEDERAL FISH HATCHERIES IN THE STATE OF WASHINGTON WITHOUT THE LOSS OR DAMAGE OF A SINGLE BAG. THE EGGS WERE PACKED IN 30-POUND BERRY TINS. COST RECORDS INDICATE THAT THE COLLECTION OF ALASKA SALMON CANNERY WASTE FOR USE IN THE STATES IS COMMERCIALLY AND ECONOMICALLY FEASIBLE. SALMON VISCERA BAGGED AND FROZEN BY THE METHOD INDICATED HEREIN ARE ACCEPTABLE FOR SHIPMENT FROM ALASKA TO SEATTLE ON REGULAR COMMERCIAL REFRIGERATED VESSELS.

INTRODUCTION

Research toward utilization of Alaska salmon cannery waste has been carried out since 1947 by the U. S. Fish and Wildlife Service. Particular emphasis has been placed on utilization of visceral portions of the waste as a feed for hatchery fish and on the use of the whole waste or the waste excluding heads for fur-animal food. This research has shown that the waste and the soft visceral parts, in particular, are an excellent source of protein and vitamins and that much of the vitamin content and the best protein are concentrated in the fish eggs. In developing a practical method of utilizing these materials from Alaska salmon canneries, several problems had to be overcome.

Transportation charges from Alaska are an important item in the over-all cost of collection and delivery of such material to potential users. Transportation companies have insisted that salmon offal would be acceptable for transportation only if it were packed in metal containers. This, in effect, would virtually double the freight on such materials, because the cost for shipping the empty containers to Alaska would approximately equal the cost of returning the filled containers (of course, the freight rate for any frozen material on the return shipping would be slightly higher). Experiments with different types of containers resulted in development of a method of bagging the salmon waste in an inner plastic (polyethylene) bag with an outer burlap bag. Laboratory tests indicated that such a container would withstand the bagging and freezing operations and the subsequent rough handling that it would normally encounter.

* CHEMIST, FISHERY PRODUCTS LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U. S. FISH AND WILDLIFE SERVICE, KETCHIKAN, ALASKA.
** CHEMIST,
*** CHIEF, PACIFIC COAST AND ALASKA TECHNOLOGICAL RESEARCH, (FISHERY TECHNOLOGICAL LABORATORY, BRANCH OF COMMERCIAL FISHERIES, U.S. FISH AND WILDLIFE SERVICE, SEATTLE, WASHINGTON.

Another problem that had to be overcome was the development of a practical method for the separation of the soft visceral portion and of the eggs alone from the entire waste. The waste as it comes from the "Iron Chink" contains heads, tail portions, fins, viscera, and eggs. Preliminary observations made at canneries during the summer of 1950 indicated that several approaches to the problem were possible. However, the most desirable method, if feasible, would involve complete mechanical separation right at the Chink--such that the desired, soft visceral portions might be diverted separately from the other waste onto a packing table. This would avoid any costly hand separation of the individual constituents of the waste.

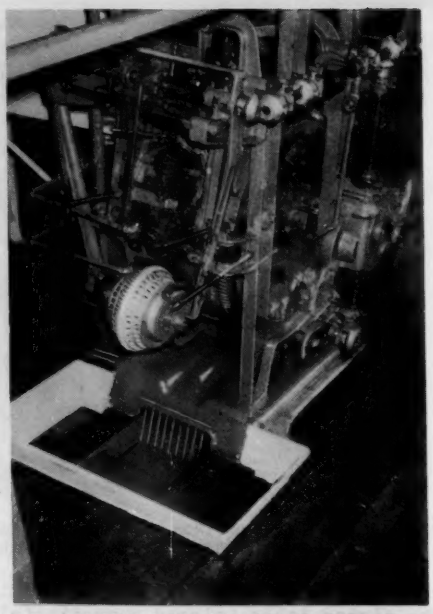


FIG. 1 - REAR VIEW OF IRON CHINK SHOWS THE GRATE IN THE FLOOR THROUGH WHICH THE VISCERA WERE DIVERTED INTO A WOODEN CHUTE UNDERNEATH THE CANNERY FLOOR.

COMMERCIAL-SCALE TEST

A large-scale collection of approximately 100,000 pounds of frozen salmon viscera and 3,000 pounds of frozen salmon eggs was made at Petersburg, Alaska, during the summer of 1951. The purpose of this collection was to test out on a commercial scale the feasibility of bagging and freezing viscera and to demonstrate to the commercial transportation concerns that such materials could be successfully handled in this way. This would possibly clear the way for a change in the regulations to allow shipment in bags rather than in cans, since use of cans is not economically feasible. The materials collected are being used by Fish and Wildlife Service hatcheries in the state of Washington for regular fish feeding. Careful records were kept of all costs involved in the collection so that in the future some basis would be available for estimating such costs for even larger scale operations. It was anticipated that if the collection of the salmon waste for use in fish hatcheries proved to be economically feasible, a much larger potential market (a feed for fur-bearing animals) would be opened up and that many millions of pounds of such materials might be marketed each year.

Details concerning the laboratory research on this project will be published at a later date. The balance of this report deals with results of the large-scale collection of salmon viscera and eggs at Petersburg, Alaska, during August 1951.

INSTALLATION OF EQUIPMENT AND COLLECTION OF WASTE

After consultation with operators of the cannery at Petersburg, shields were devised and installed at the rear of the Iron Chink to separate the viscera from the bony portions of the salmon waste. Besides the shields, the following equipment was installed at the cannery: A gurry chute, 10 by 10 inches by 60 feet; a work platform, 12 by 20 feet, located 7 feet below the dock level; a draining table, 8 feet by 29 inches, made of 2 by 4-inch pieces placed on edge and spaced three-eighths of an inch apart; and a slide, 15 feet long, from the surface of the dock to the work platform, on which an elevator moved.[1/]

1/COMPLETE DETAILS ON THIS CONSTRUCTION WORK MAY BE OBTAINED BY WRITING TO THE KETCHIKAN (ALASKA) OR SEATTLE (WASHINGTON) TECHNOLOGICAL LABORATORIES.

FIG. 2 - SIDE VIEW OF IRON CHINK. SHOWS (AT LEFT) THE SHIELD BUILT AROUND THE VISCERA GRATE AND (LOWER CENTER) THE FINS PILED OVER THE FIN GRATE.

By means of shields (figures 1 and 2) installed at the rear of the Iron Chinks, the viscera were diverted through a grate in the floor of the cannery into a wooden chute (10 by 10 inches by 60 feet) installed underneath the cannery floor. The viscera were carried down the chute by water from the sprays on the Chinks onto the draining table. A series of trap doors installed in the chute was used to control the rate of flow. As the viscera from the three Chinks, with much excess water, flowed onto the draining table (figure 3), any undesirable portions were picked out and discarded. Four men were necessary for the operation. One man controlled the flow and raked the viscera down the sloped table (sloped approximately 6 inches in 8 feet) to the second man (figure 4), who sacked the drained material (figure 5). The filled sack was passed to the third man who knotted the top of the polyethylene bag and wire-tied the outside burlap bag (figure 5). The secured sack was then placed on the elevator (figure 6). The fourth man hand-winched the loaded elevator (six sacks) up to dock level, removed the sacks, and returned the elevator to the platform. The fourth man also made up sacks, that is, placed the polyethylene bag inside the burlap bag (figure 7).

FIG. 3 - DRAINING TABLE. VISCERA FLOW ONTO AND ARE RAKED DOWN THE SLOPED TABLE; THE WATER FALLS THROUGH THE OPENINGS. ONE OF THE TRAP DOORS TO CONTROL THE RATE OF FLOW IS LOCATED AT THE END OF THE CHUTE (RIGHT CENTER).

At approximately 3:15 p. m. each day, a dump truck transported the day's output to the cold-storage plant. Two trips were usually necessary. The collection crew of four men loaded the truck, and two of the men (cold-storage workers) accompanied the truck to the cold-storage plant where the sacks were dumped near the freezer door. These men then hand-trucked the sacks into the freezer (average temperature of -18° F.) and placed them on the freezer plates (figure 8). This operation usually took two men approximately one hour per 100 sacks. Each day two hand-truck loads of sacks (10 sacks per truck) were weighed. The average weight was approximately 65 pounds per sack.

Normally the sacks of viscera were

solidly frozen in 24 hours. After 300 to 400 sacks accumulated in the freezers, they were moved to the storage room by the regular cold-storage plant crew (figure 9).

FIG. 4 - ANOTHER VIEW OF THE DRAINING TABLE SHOWS THE VISCERA FLOWING DOWN THE CHUTE, THROUGH THE TRAP DOOR, AND ONTO THE DRAINING TABLE.

PROBLEMS ENCOUNTERED

Following are the two main problems encountered during the collection: (1) Fish missed by the Iron Chink (that is, the fish fed into the Iron Chink that were not carried through but dropped) would fall onto and clog the fin grate (figure 2). The fins would then rapidly pile up on the floor. When this build-up of material became too high the fins would wash underneath the Chink, down through the rear grate (figure 1) into the viscera chute, and then onto the draining table where they had to be picked out from the visceral portion. The only remedy for the above problem, without interfering with the cannery operation, was to periodically clean off the fin grate. This solution was not ideal. (2) Separation of the soft visceral portions made disposal of the remainder of the trimmings more difficult. Ordinarly, the whole waste flowed easily from the gurry bin into the scow. Since approximately 85 percent[2/] of the viscera, or soft portions, were diverted for the collection operation, very little of this material entered the cannery's gurry bin. The mass of heads, tails, and fins were difficult to remove from the bin. This difficulty required the use of additional personnel to empty the bin and then to dump the scow; normally, one man carried out the entire operation. This problem could possibly be solved by building more slope into both bin and gurry scow.

FIG. 5 - THE DRAINED VISCERA ARE SACKED (RIGHT) AND THE BURLAP BAG IS WIRE-TIED (CENTER).

Under optimum conditions (when this particular cannery was running all three Iron Chinks steadily), a maximum of thirty-five 65-pound sacks of viscera were collected in an hour. These conditions were seldom attained because most of the

2/ IT IS ESTIMATED THAT 60 TO 70 PERCENT OF THE THEORETICAL YIELD OF VISCERA WAS COLLECTED. THIS VALUE WAS BASED ON THE ESTIMATE OF 25 POUNDS OF WHOLE WASTE PER CASE OF SALMON. THE VISCERA REPRESENT 29 PERCENT OF THE WHOLE WASTE OR 7.3 POUNDS OF VISCERA PER CASE OF SALMON. SOME OF THE LOSS OF VISCERA, PROBABLY UP TO 15 PERCENT OF THE TOTAL AMOUNT, OCCURRED AT THE DRAINING TABLE WHERE THE SMALL PORTIONS FELL THROUGH THE SLOTS.

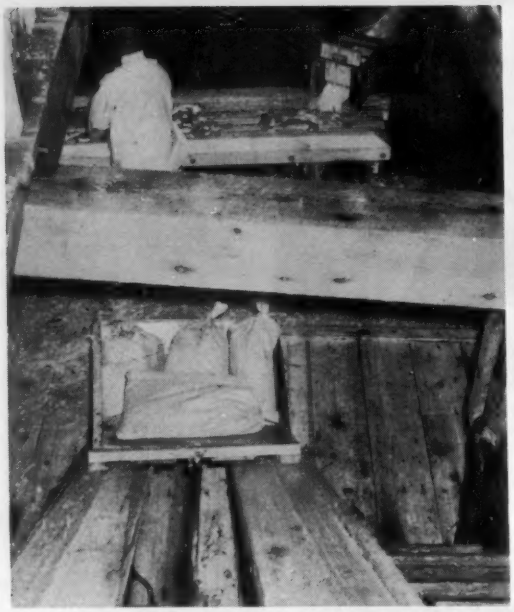


FIG. 6 - THE SACKS OF VISCERA ARE LOADED ONTO THE ELEVATOR AND ARE HAND-WINCHED FROM THE PLATFORM UP TO THE DOCK LEVEL.

collection was made during the first half of the season at a time when the cannery was not operating at full capacity. An average of 120 sacks per day (range of 90 to 150) was collected with the facilities used.

During an eight-hour shift, only one-half to three-fourths of the time of the workers was spent in actual collection of the material. The remainder of the time was spent in taking the material to the cold-storage plant, emptying the gurry bin and dumping the gurry scow, and making minor adjustments to and cleaning the equipment. Also, the collection was carried out over only a portion of the season, and only until the desired quota of 100,000 pounds was reached. Had operations continued for the final ten days of the season, the prorating of certain fixed costs and capital investments for a larger production would have resulted in a smaller unit cost per pound of the viscera and eggs.

COSTS OF COLLECTION OF WASTE

Table 1 lists the costs of collecting the salmon viscera. Only the costs of the actual materials and services necessary for the viscera collection are given.

Cost of all man hours involved in the actual collection are figured at the rate of $2.00 per man hour straight time and $3.00 per man hour overtime.

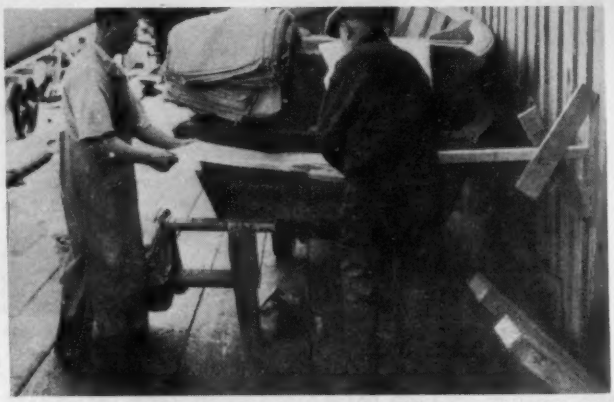


FIG. 7 - THE MEN ARE PULLING THE POLYETHYLENE BAG OVER THE SACK STAND; A BURLAP BAG (UPPER CENTER) IS THEN PULLED OVER ON THE OUTSIDE OF THE POLYETHYLENE BAG. THE COMPLETED CONTAINERS ARE PILED ON THE STAND BEHIND THE MAN ON THE LEFT.

Table 2 gives information on the cost breakdown for the collection of frozen salmon eggs; table 3, information on shipping costs from Petersburg, Alaska, to Seattle; and table 4, costs in cents per pound for collection of salmon viscera and eggs, calculated f.o.b. Petersburg and f.o.b. Seattle. The cost f.o.b. Seattle of the viscera is 5.21 cents, and of the eggs is

7.75 cents per pound (not including capital investments or depreciation). In comparison, the Fish and Wildlife Service hatcheries in 1951 paid 9 cents per pound

Table 1 - Cost of Collection of 100,750 Pounds of Salmon Viscera F.O.B. Steamship Dock, Petersburg, Alaska

Item	Cost
Material: 1,600 burlap bags	$ 479.00
1,600 polyethylene liners	258.00
2,000 wire ties	5.00
1 wire-tying tool	2.00
Shipping Seattle to Petersburg	18.00
Viscera (100,750 lbs. at $0.005 per lb.)	503.75
Freezing and Storage ($7.00 per 1,000 lbs.)	705.25
Hauling by Transfer Co. ($6.00 per hour)	50.00
Labor for the Collection (396.5 hrs. at $2.00 per hr.)	898.00
(35 hrs. at $3.00 per hr.)	
Cold-Storage Handling Charges	87.00
Longshoring	78.00
	$3,084.00

for eggs obtained in the Pacific Northwest. The price paid for salmon waste has varied with the degree of separation of the heads, tails, and fins from the soft visceral parts. The amount paid for the viscera, equal in quality to that obtained in this collection, has been greater than 5 cents per pound.

Table 2 - Cost of Collection of 3,000 Pounds of Frozen Eggs F.O.B. Steamship Dock, Petersburg, Alaska

Item	Cost
Material: 30-lb. Berry Tins and Lids	$ 38.00
Shipping Cost Seattle to Petersburg	35.00
Eggs ($0.005 per pound)	15.00
Labor for Collection	56.00
Freezing and Storage	21.00
Cold-Storage Handling Charge	2.50
Longshoring	6.50
Hauling by Transfer Co.	3.00
	$ 177.00

Observations on the adequacy of packaging, using the polyethylene bags within burlap, were made by Service personnel during handling at Petersburg and on arrival at destination. Examination by representatives of a commercial steamship company was made at destination.

Table 3 - Shipping Cost of Salmon Viscera and Eggs from Petersburg, Alaska to Seattle, Washington

Item	Cost
Transportation of 1,550 sacks of Viscera (2,722 cu. ft. at $0.675 per cu. ft.)	$1,837.35
Wharfage and Handling (Petersburg and Seattle) (2,722 cu. ft. at $0.12125 per cu. ft.)	330.04
Total	$2,167.39
Transportation of 100 Cans of frozen eggs (66.8 cu. ft. at $0.7125 per cu. ft.)	$ 47.60
Wharfage and Handling (Petersburg and Seattle) (66.8 cu. ft. at $0.12125 per cu. ft.)	8.10
Total	$ 55.70

Table 4 - Summary of Costs for Salmon Viscera and Eggs

Item	Price Per Pound F.o.b. Steamship Dock, Petersburg, Alaska	Shipping Cost, Per Pound, From Petersburg, Alaska, to Seattle, Wash.	Price Per Pound F.o.b. Steamship Dock, Seattle, Wash.1/
	Cents	Cents	Cents
Viscera (in bags)	3.06	2.15	5.21
Eggs (in 30-lb. berry tins)	5.90	1.85	7.75

1/CAPITAL INVESTMENTS AND DEPRECIATION COSTS NOT INCLUDED, SINCE THEY WOULD ORDINARILY BE PRORATED FOR THE ENTIRE SEASON OVER A PERIOD OF YEARS. ALSO, THE COSTS WILL VARY WITH THE LOCATION OF THE CANNERY, RATES FOR LABOR, TYPE OF CONSTRUCTION, AND ENVIRONMENTAL CONDITIONS. FOR THIS PARTICULAR OPERATION THE COST OF MISCELLANEOUS SUPPLIES AND CONSTRUCTION REQUIRED FOR THE ENTIRE COLLECTION AMOUNTED TO $413.19. THIS AMOUNT, UNDOUBTEDLY, WILL REPRESENT AN AVERAGE INVESTMENT THAT MIGHT BE EXPECTED FOR A THREE-LINE SALMON-CANNERY OPERATION.

The container employed for this purpose was a 0.002-inch thick polyethylene transparent bag, (19 inches wide and 42 inches long) placed inside a burlap bag (18 inches wide by 36 inches long). The burlap bag, being smaller than the plastic liner, takes up most of the strain during packing, freezing, and handling operations. This size of bag would hold, if filled completely, about 100 pounds of material. However, by placing only 65 pounds of material in the bags, handling was greatly facilitated. Greater ease in closing the polyethylene bag resulted inasmuch as it was possible to tie a knot in the polyethylene bag for a rapid, secure closure. It seems that 65 pounds is the best weight for ease of handling; also, this size package fits between freezer plates more readily than a 100-pound size.

The 65-pound bags of unfrozen salmon viscera were subjected to extremely rough handling without rupturing the polyethylene liners or otherwise damaging the bags. Unfrozen bags of viscera were loaded into a dump truck for transportation from the cannery to the freezer. Upon arrival at the freezer, they were dumped onto the floor, during which process some bags fell 6 feet or more onto the concrete floor or onto other bags. This rough treatment did not necessitate the rebagging of a single container.

The bags were still in excellent condition after they were handled in the usual manner, at the cold-storage plant and after they were unloaded at Bellingham or Seattle, Washington. No difficulty was experienced in bags sticking to freezing plates or to each other.

FIG. 8 - THE SACKS OF VISCERA ARE LYING ON THE FREEZER PLATES (LEFT) WHERE THEY ARE NORMALLY FROZEN SOLID IN 24 HOURS; THE CANS CONTAINING THE EGGS WERE FROZEN WHILE STACKED ON THE FLOOR.

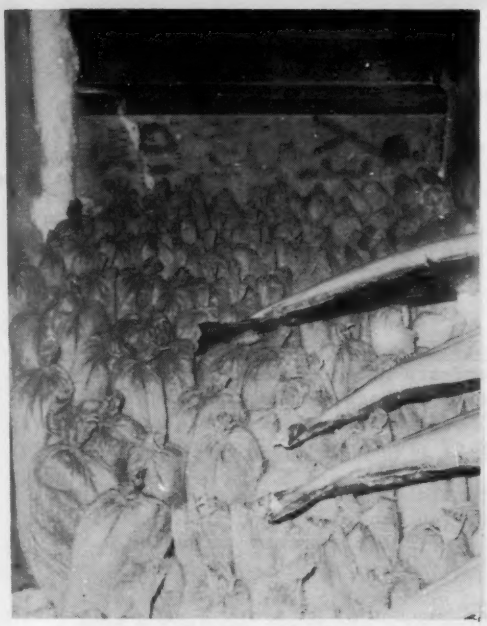


FIG. 9 - THE FROZEN SACKS OF VISCERA ARE STORED IN REGULAR COLD-STORAGE ROOM AWAITING SHIPMENT TO SEATTLE; THE FISH (BOTTOM CENTER) ARE FROZEN HALIBUT.

The containers were clean with no .ish material adhering to them. Inspection of the shipment at different points en route to the hatchery and after arrival at the hatchery failed to show a single bag which had lost any of its contents or which needed rebagging for any reason whatever.

The shipments from Alaska to Washington were made in two lots. The first shipment of about 60,000 pounds would not be accepted by any commercial steamship company because, contrary to regulations, the viscera were packed in bags rather than metal containers. The first shipment was made aboard a refrigerated vessel belonging to one of the salmon canneries, and delivery was made at Bellingham, Washington. Inspection of this shipment by representatives of a regular commercial steamship company convinced them that such a method of packaging would probably be satisfactory. Accordingly, they agreed to ship the second lot of about 40,000 pounds. This shipment was in excellent condition when it arrived in Seattle. The steamship company officials indicated, therefore, that future lots of salmon viscera bagged and frozen as indicated herein would be accepted for shipment from Alaska to Seattle on their regular commercial refrigerated vessels.

ACKNOWLEDGMENT

Acknowledgment is made to: Pacific American Fisheries, Inc., for the use of their facilities, and in particular to Mr. Ivan Finsberg, superintendent; Mr. Ralph Erickson, foreman; and other personnel at the company's cannery at Petersburg, Alaska, whose cooperation and assistance made this salmon waste collection possible; the Alaska Fisheries Experimental Commission for the use of their facilities and personnel; Mr. William A. Hagevig, Laboratory Assistant for the Alaska Fisheries Experimental Commission, for assistance in the planning and engineering the installations made at the cannery and for assisting in the collection of the viscera.

TECHNICAL NOTE NO. 12 -- SUGGESTED CODE FOR FISH MEAL

The California Hay, Grain, and Feed Dealers Association has been working on the establishment of a code for fish meal, use of which will be voluntary with the producer as well as with the buyer.

The following is the proposed code:

I. TEXTURE AND COMPOSITION.

A. Uniform grind, color, and protein content per lot: Differences between lots, in grind and color, are not desirable but are not as unsatisfactory as differences between bags within the same lot. The protein content of individual bags within a lot should not vary over a range greater than 5 pounds of protein per 100 pounds of meal.

B. Maximum particle size: All particles should pass a No. 7 Tyler standard screen or a U. S. No. 7 standard screen, and 98 percent of the particles should pass a No. 9 Tyler standard screen or U. S. No. 10 standard screen.

C. Moisture: An average moisture content of 8 percent, with a deviation not greater than plus or minus 2 percent, is satisfactory. A moisture content as high as 12 percent places the meal in the danger zone for heating and spoilage; a moisture content of less than 6 percent is contrary to present shipping regulations.

D. Fat: The fat content should not be less than 5 percent nor more than 10 percent, and preferably not more than 8 percent. A low fat content is undesirable because of dustiness. A high fat content increases the hazard during storage.

E. Labelling: All statements appearing on the tag are the manufacturer's responsibility. The tag should have on it the name of the manufacturer, the kind of fish meal, and the number of the lot.

II. MAINTENANCE OF QUALITY.

A. Manufacturing: In drying the meal, avoid dehydrating it to less than 6 percent, and avoid overheating it, both of which impairs protein quality.

B. Curing: The meal should be cooled and cured prior to sacking. Heating during shipment may cause lumping and loss of quality. Sweating may cause moisture condensation, wetting, and mold growth.

III. PACKING AND SHIPPING.

A. Weight: The sack should contain not less than 100 pounds on the standard moisture basis.

B. Bag Size: To facilitate piling the bags, use one size of bag in any given shipment.

C. Sterilizing: Used bags should be cleaned and sterilized in order to prevent the spread of communicable animal diseases.

D. Preventing damage: Use "temporary car doors" to protect the bags against damage when the car doors are opened.

E. Separating lots: If more than one lot of meal is shipped per car, the lots should not be mixed indiscriminately but should be clearly separated by means of paper or other suitable dividers.

UTILIZATION OF FISHERY BYPRODUCTS IN WASHINGTON AND OREGON

Very little fish scrap is being discarded in the States of Washington and Oregon. The small amount not utilized is either in an area where the supply is inadequate to support a commercial operation, or else the material is of such a nature that it does not command a market. Companies have failed because the supply of waste has been insufficient. Others have lost money on the production of materials not in demand. Anyone who intends to enter the field of byproducts should, therefore, make a thorough survey of the source of supply and the market for the finished product.

The byproducts industry is not static. Changes are taking place, and the field is becoming increasingly competitive. Fish waste, in earlier years, was thrown away. Later, it was utilized only by reduction plants. Now it is in demand for reduction purposes and for mink feed and other uses. With few exceptions, the operations have not produced appreciable revenue, and many firms have operated largely on a marginal basis. For this reason, there is a continuing and increasing pressure to find more remunerative uses for the waste. The problems to be solved are not easy; but with a rapid acceleration in technological knowledge and the demands of a growing population, further changes are inevitable.

Fish waste in Washington and Oregon is utilized as the whole waste or is separated into its various components and selected portions utilized. The whole waste is used in fish hatcheries, on fur farms, in pet food, and in reduction plants. The selected portions used are the skins, eggs, and livers and viscera. The skins are processed for manufacture into leather for women's shoes; the eggs are made into caviar and fish bait; and the livers and viscera are rendered for oil and vitamin A.

The most important producing areas in Washington are Puget Sound, Grays Harbor, Columbia River, and Willapa Harbor. In Oregon, the Astoria-Warrenton-Hammond area is the center of greatest production. Also important are Yaquina Bay, Coos Bay, and Tillamook Bay.

--By F. Bruce Sanford --Fishery Leaflet 370

TECHNICAL NOTE NO. 13--ACCEPTABILITY AND KEEPING QUALITY OF PACIFIC OCEAN PERCH FILLETS

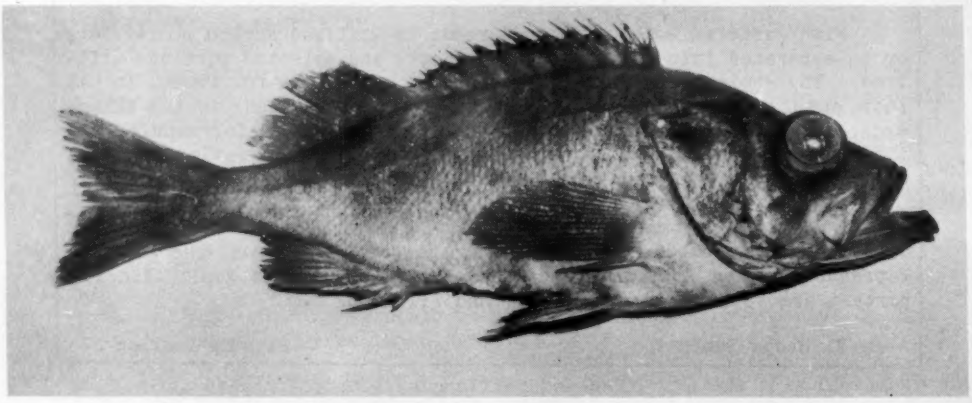
Recent developments which permit Sebastodes alutus to be marketed as "Pacific ocean perch" raise the possibility of the creation of a new commercial fishery in the Pacific Northwest. This species resembles the Atlantic Coast ocean perch or rosefish (Sebastes marinus) more nearly than it does the other rockfishes.

Until recently Sebastodes alutus was a little known member of the rockfish group of fishes. During the past few years a number of otter trawl vessels increased the length of their trawling gear in order to drag in depths approaching 100 fathoms. When this gear was used in certain areas adjacent to the Oregon coast, huge schools of rockfish, often made up almost completely of Pacific ocean perch (Sebastodes alutus), were encountered. Prior to this time, the widespread occurrence of this species at considerable depths had not been suspected.

Further evidence as to the widespread occurrence of Pacific ocean perch was obtained by the Service's exploratory vessel, John N. Cobb (Alverson and Welander). During exploratory operations in 1950 it was observed that small fish of this species were an important part of the diet of albacore tuna caught from the northern end of the Queen Charlotte Islands to Cape Blanco, Oregon, and from 30 to 380 miles offshore.

During the summer of 1950, the Seattle Technological Laboratory collected samples of Pacific ocean perch (Sebastodes alutus), ocean perch (Atlantic) (Sebastes marinus), and several species of commercially-important Pacific Coast rockfish. The purpose of this collection was to determine the relative initial palatability and the cold-storage life of these species. All samples were put up commercially by regular packing procedures. They were frozen and then stored at 0° F. Organoleptic observations were made on the fillets immediately after freezing and after various storage intervals. The fillets were examined by a testing panel for appearance, flavor, and texture.

The initial palatability of the Pacific ocean perch was superior to that of any of the other Pacific Coast rockfishes. Texture especially was more tender.



PACIFIC OCEAN PERCH (SEBASTODES ALUTUS)

Before any cold-storage period had begun, all rockfishes and the ocean perch (Atlantic) were of good flavor and color. The Pacific ocean perch had less dark meat in the surface layer beneath the skin than the other Pacific Coast species.

When the Pacific ocean perch was compared with the ocean perch (Atlantic) before cold storage had begun, a slight preference was expressed by the testing panel in favor of the Atlantic species. This was based upon a more tender texture. However, the difference was quite small.

When the various species were held in cold storage at 0° F., all underwent changes resulting in slow to rapid deterioration. The texture tended to become tough. The flavor indicated varying degrees of rancidity. The color of the fillets, especially of the dark layer beneath the skin, became still darker. These changes were most extreme with the various species of Pacific Coast rockfish other than Pacific ocean perch. Sebastodes pinninger (a red or orange rockfish extensively packed commercially) had undergone considerable change after four months of storage and after five months was considered of dubious salability. Sebastodes ruberrimus (commonly referred to in the Pacific Northwest as red rockfish or "red snapper") showed especially rapid initial deterioration, being definitely and adversely altered after only two months at 0° F. Fillets from this fish were considered unsalable, or nearly so, after six months of storage.

The Pacific ocean perch did not show any extensive changes until after six months storage at 0° F., and was considered of marketable quality until it had been in storage for eight months. The ocean perch (Atlantic) had nearly as great a storage life as the Pacific ocean perch and had reached the same stage of deterioration after seven-and-one-half months at 0° F. as the Pacific ocean perch reached in eight months. There was very little difference between the Pacific ocean perch and the ocean perch (Atlantic) as to general acceptability. Before extensive cold storage there was a slight preference for the ocean perch (Atlantic), but after several months at 0° F. the Pacific ocean perch received a slight preference. Contrasted to this, the common red rockfish species (S. pinninger and S. ruberrimus) had lower initial palatability and much shorter cold-storage life.

When Pacific ocean perch are caught in depths of about 100 fathoms, they are usually found in schools which contain few other species of rockfish. Two rockfish species which most frequently accompany Pacific ocean perch are S. diploproa (no common name) and an unidentified species known locally in Oregon as "idiot." These are small red rockfish resembling fairly closely the Pacific ocean perch. The S. diploproa occurs more frequently with Pacific ocean perch than does the "idiot." In table 1 are tabulated results of storage tests on the Pacific ocean perch and the S. diploproa and "idiot" species as well as two other species of rockfish (S. ruberrimus and S. pinninger) which are handled quite extensively in

Table 1 - Cold Storage Life of Several Species of Rockfish (Sebastodes) and Ocean Perch (Atlantic) (Sebastes)

Species of Rockfish		Cold Storage Life at 0° F.
Scientific Name	Common Name	Months
S. alutus	Pacific ocean perch	8
S. _____ (unidentified)	"idiot"	7
S. diploproa	none	6
S. ruberrimus	"red snapper"	6
S. pinninger	orange rockfish	5
Sebastes marinus	Ocean perch (Atlantic)	7½

the commercial fishery. Pacific ocean perch had the longest storage life (eight months) at 0° F., closely followed by the "idiot" species (seven months). The S. diploproa had a storage life of only six months (equal to that of S. ruberrimus). At the bottom of the list is the orange rockfish (S. pinninger) which is one of the most frequently handled rockfish in the commercial fishery.

In view of the superior cold-storage life of the Pacific ocean perch as contrasted to that of the species of rockfishes ordinarily packed commercially on the Pacific Coast, it would appear that it should be possible to market frozen Pacific ocean perch without any great technological difficulties arising with respect to deterioration in cold storage. If the species will withstand intensive fishing, it may be possible to develop an extensive commercial fishery for Pacific ocean perch.

LITERATURE CITED

ALVERSON, DAYTON L., AND WELANDER, ARTHUR D.
——. NOTES AND KEY TO THE SPECIES OF ROCKFISH SEBASTODES OF WASHINGTON AND ADJACENT AREAS. (UNPUBLISHED MANUSCRIPT)

--M. E. Stansby, Chief,
Pacific Coast and Alaska
Technological Research,
Seattle, Washington.

THE EFFECT OF A SEAFOOD DIET ON THE RED CELL COUNT, HEMOGLOBIN VALUE, AND HEMATOCRIT OF HUMAN BLOOD

Seafood products are of major importance for their nutritional value. It is reasonable to suppose that marine animals living in a medium containing all the mineral elements needed by the human body would be a highly nutritious class of food. Since the minerals may be supplied to us in a usable form, by marine animals, we can get iron and copper to prevent nutritional anemia, iodine to prevent goiter, as well as phosphorous, copper and magnesium which are needed to regulate other body functions.

Oysters, shrimp, and crab meat, in addition to being rich sources of iron, copper and iodine contain one-half as much calcium, three times as much magnesium, and much more phosphorus than an equal quantity of milk. The oyster is comparable to liver and to milk, in its rich sources of nutrients. One pound of oysters provides about 12 percent of the energy needed by a man for one day; also, 50 percent of the protein, 26 percent of the calcium, 40 percent of the phosphorus, over 184 percent of the iron, and about 110 percent of the iodine, as well as vitamin A, thiamine, riboflavin and ascorbic acid.

Fish, as well as shellfish, are good sources of protein, phosphorus, iron, and iodine. The protein content of fish is comparable to beef and liver, and is higher than that of milk.

--By Shirley J. Wilson --Fishery Leaflet 334

TECHNICAL NOTE NO. 14--A BRIEF STUDY OF THE ALKALI PROCESS FOR RECOVERY OF OIL FROM PINK SALMON CANNERY WASTE

ABSTRACT

THE EFFECTS OF VARYING THE TIME OF DIGESTION OF A FEW SAMPLES OF PINK-SALMON CANNERY WASTE AT CERTAIN TEMPERATURES AND ALKALI (SODIUM HYDROXIDE) CONCENTRATIONS WERE STUDIED. AT 200° F. AND WITH 1.5 PARTS OF SODIUM HYDROXIDE PER 100 PARTS OF WASTE, THE MAXIMUM RECOVERY OF OIL WAS OBTAINED BY DIGESTING ABOUT 35 TO 40 MINUTES. AT 180° F. WITH THE SAME AMOUNT OF ALKALI, THE DIGESTION WAS VERY SLOW AND NO TIME FOR MAXIMUM RECOVERY WAS DETERMINED. AT 240° F. AND THE SAME ALKALI CONCENTRATION, THE DIGESTION WAS DIFFICULT TO CONTROL; TIME FOR MAXIMUM RECOVERY AT THAT TEMPERATURE APPEARED TO BE ABOUT 20 MINUTES. AT 200° F. WITH 3.0 PARTS OF SODIUM HYDROXIDE PER 100 PARTS OF WASTE, MAXIMUM RECOVERY WAS ATTAINED BY DIGESTING ONLY 15 TO 20 MINUTES, BUT THE FORMATION OF EMULSION WAS EXCESSIVE. IN EVERY CASE THE RATES OF CHANGE IN OIL RECOVERY ON BOTH SIDES OF THE OPTIMUM TIME WERE SMALL; THAT IS, THE OPTIMA TIMES WERE NOT CRITICAL.

INTRODUCTION

The potential value of the oil in salmon cannery trimmings has been more or less appreciated for many years. However, the bulk of this raw material is still being wasted, because data on possible reduction methods have been insufficient to assure cannery operators of profits commensurate with the investment. A process which might prove sufficiently profitable is the digestion of the trimmings with an alkali and the separation of the oil with a centrifuge. Such a process has proved highly successful for the recovery of vitamin oils from fish livers and viscera. Anderson (1945) recommended an alkali digestion process for the recovery of oil from the head-collar portion of salmon cannery waste. Butler and Miyauchi (1947) adapted Anderson's method to pilot-plant-scale digestions of several types of salmon cannery waste. Carlson and Magnusson (1948), using frozen pink-salmon waste only, made a preliminary study of the effects on oil recovery of particle size, time, temperature, and alkali concentration. They concluded that the waste should be ground or shredded but that extreme disintegration was unnecessary. Although they found that digestion at 200° F. for about 50 minutes with 1.5 parts of sodium hydroxide to 100 parts of waste was fairly satisfactory, they recognized the need for more experimental data on each of the variables.

In order to secure additional data on the effect of varying the digestion conditions, seven series of four (in one case three) trials each were performed and at near conditions previously found quite satisfactory. The only variable for the four trials within each series was the time of digestion. Three series of digestions were carried out at 200° F. with 1.5 parts of sodium hydroxide per 100 parts of waste; in two series at the same temperature 3.0 parts of alkali per 100 parts of waste were used; in one series at 180° F. and in another at 240° F., 1.5 parts of alkali per 100 parts of waste were employed.

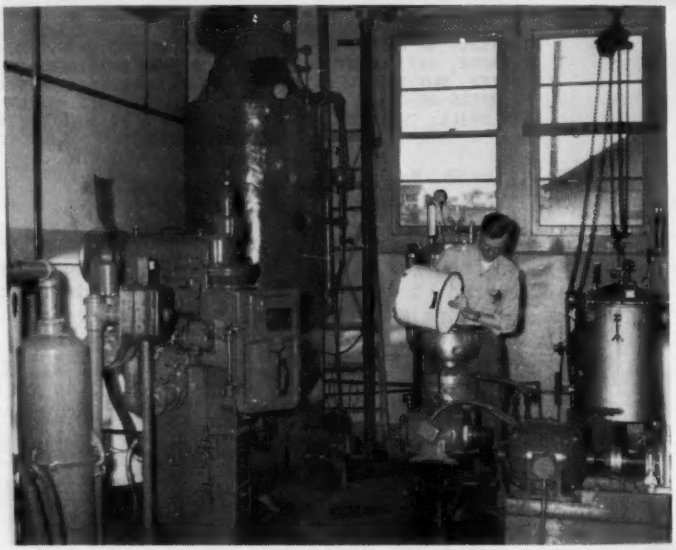
The advantages of using a single lot of raw material for all the series were recognized; however the limitations of physical equipment and personnel permitted only one series of four trials on each operating day. As spoilage in unfrozen waste is rapid and as freezing the waste would be commercially imprac-

NOTE: RESEARCH ACCOMPLISHED AT KETCHIKAN FISHERY PRODUCTS LABORATORY, WHICH IS JOINTLY OPERATED BY THE FISHERIES EXPERIMENTAL COMMISSION OF ALASKA AND THE U.S. FISH AND WILDLIFE SERVICE.

tical, new well-mixed lots of fresh waste were used for each series of four digestions. Therefore, the oil recovery data of a trial in one series cannot be compared directly with the data of a trial in another series. The present study is primarily a study of the effect of varying the digestion time under four sets of temperature and alkali conditions.

PROCEDURE AND EQUIPMENT

Whole pink-salmon cannery waste was secured at a Ketchikan cannery, which handled only trap-caught fish. Representative lots of waste were collected in wire baskets directly from the end of the flumes coming from the butchering and cleaning operations. After the waste was well drained, it was taken immediately to the laboratory and put through a meat-bone chopper (hogger). The final hogged mass consisted of pieces not over one-half inch in narrowest width. The entire lot of ground material was mixed and then divided equally into four sublots of approximately 100 pounds apiece. At the same time a moderate sized representative sample was removed. This sample was reground in a laboratory meat grinder, and the well macerated mass was quartered to obtain the proper size sample for analysis. The oil content of the sample was determined by extraction with acetone in a Baily-Walker apparatus and purification of the extract in ethyl ether in accordance with the method of Stansby and Lemon (1937), as modified by Voth (1946).



PILOT PLANT EQUIPMENT USED FOR PINK SALMON WASTE STUDY AT KETCHIKAN FISHERY PRODUCTS LABORATORY. SHOWN ARE STEAM BOILER, CENTRIFUGE, AND RETORT.

The digestions were carried out in the equipment described by Carlson and Magnusson (1948). This consisted of an upright 58-gallon retort fitted with steam inlets near the bottom and power-driven stirring propellors; it was equipped with an adjustable level draining-skimming device. Skimming the digestion liquors from the top was desirable, because when they were drained out at the bottom the oil layer was held back by the undigested bones. For digestion at 180° and 200° F., a sheet aluminum lid was placed on the retort. The temperatures were noted with an all-metal dial-type thermometer having a 24-inch stem. For digestions at 240° F., a regular pressure retort cover (clamped down with turnbuckles and equipped with a thermometer and a pressure gauge) was used.

In preliminary tests it was found that whenever the digestion had been started with cold water there was excessive bumping. Therefore, before each trial the necessary water was heated to about 180° F. by injecting steam. The amount of hot water was adjusted to 12 gallons (100 lbs.), the stirrer was start-

ed and the sodium hydroxide was added. As soon as the alkali had dissolved, the weighted waste (about 100 lbs.) was added and the steam flow was adjusted so that the desired final temperature was reached in 10 minutes. At the end of the chosen processing period the steam was turned off and the stirrer stopped, and the digested mixture was allowed to settle for 15 minutes. In the trials at 240° F. it required most of the settling period to release the pressure; when the pressure was released more rapidly the digestion mixture boiled and foamed over and much of the oil layer was lost.

After the settling period, the oil-rich top layer was skimmed off and passed through a centrifugal oil purifier which had been preheated with boiling water. Then most of the remaining supernatent liquors were also passed through the centrifuge. To eliminate possible trouble from undigested bones or flesh in the centrifuge, the liquors were passed through a 12-mesh-per-inch sieve before centrifuging. The purifier readily separated the oil, which was clear and amber colored. The odor of the oil, reminiscent of fried fresh salmon, indicated slight scorching. The oil purifier normally retained a moderate quantity of liquor, including some oil, at the end of each operation. These "held back" liquors were further separated in a small laboratory centrifuge. All the recovered oil from each trial was combined and weighed to determine the oil yield. The vitamin A content of each sample was determined spectrophotometrically on the isopropanol solution of the whole oil.

RESULTS AND DISCUSSIONS

Table 1 presents the oil recovery data for the seven series of digestions. The first series at 200° F. with 1.5 parts sodium hydroxide per 100 parts of waste indicated that the optimum digestion time (including the 10 minutes to reach the digestion temperature but not including the 15 minutes settling time) for maximum recovery of oil was probably less than 40 minutes. The second series under these conditions indicated that the optimum digestion time was probably a little more than 35 minutes. The third series indicated that the proper time was close to 36 minutes. Thus the three series checked each other well, all indicating that the probable optimum digestion time was within the range of 35 to 40 minutes. These digestions at 200° F. with 1.5 parts alkali were easy to control; there was no foaming and there was only an insignificant emulsion layer between the oil and water layers.

In the two series at 200° F. with 3.0 parts of sodium hydroxide per 100 parts of waste there was considerable emulsification, and at digestion times over 20 minutes there were excessive amounts of foam. Both series indicated that the optimum digestion time for maximum oil recovery was between 15 and 20 minutes.

At 180° F. with 1.5 parts alkali, the digestion was slow. No advantage to digestion at this low temperature was observed. No optimum digestion time was indicated by the data.

At 240° F. it was impossible to lower the pressure rapidly, and therefore the digestion probably continued at a significant rate during the settling period. Digestion of pink salmon waste with 1.5 percent sodium hydroxide at 240° F. yielded a thick emulsion which was difficult to centrifuge. The optimum processing time (not including the settling period) for this temperature appeared to be around 20 minutes.

The spectrophotometric data indicated only moderate amounts of vitamin A in the raw materials used, averaging less than 1,000 U.S.P. units per gram of oil. On the basis of the spectrophotometric data on the raw oils and the

Effect of Varying Time, Temperature, and Alkali Concentration on Recovery of Oil in Alkali Digestion of Pink-Salmon Waste

Amount of Sodium Hydroxide Added Per 100 lbs. of Waste	Digestion Temperature	Oil Content of Raw Material Per 100 lbs. of Waste	Digestion Time1/	Oil Recovered Per 100 lbs. of Waste	Efficiency of Oil Recovery2/
Lb.	Degrees F.	Lb.	Minutes	Lb.	Percent
1.5	200	8.8	20	4.4	50
			30	5.6	64
			40	6.2	70
			60	5.4	61
		8.3	25	5.5	66
			35	6.4	77
			50	5.9	71
			70	5.4	65
		7.6	28	5.0	66
			36	5.3	70
			42	5.0	66
3.0	200	8.0	10	4.5	56
			15	5.3	66
			20	5.2	65
			30	4.7	59
		7.8	12	3.7	47
			17	4.3	55
			22	3.8	49
			27	3.8	49
1.5	180	8.1	30	3/	-
			45	4.2	52
			60	4.3	53
			70	4.3	53
1.5	240	7.4	10	2.5	34
			15	4.9	66
			20	5.8	78
			30	5.1	69

1/DIGESTION TIME INCLUDES 10 MINUTES TAKEN TO REACH THE DESIRED TEMPERATURE.

2/EFFICIENCY OF OIL RECOVERY = $\frac{(\text{OIL RECOVERED})}{(\text{OIL CONTENT OF RAW MATERIAL})} 100$

3/DIGESTION INCOMPLETE.

recovered oils, it was impossible to draw any significant conclusions concerning the effects of different processing procedures on vitamin A recovery.

The data for each series, except possibly those at 180° F., indicate that there is an optimum digestion time for maximum oil recovery. Presumably the amount of recoverable oil increases rapidly as the flesh disintegrates. The flesh appears to be all digested after one-half to two-thirds of the optimum time; at that point the recoverable oil amounts to about four-fifths of the maximum. After the optimum time, the amount of recoverable oil decreases slowly. When the digestion is continued for twice the optimum time, the oil recovery has only dropped to four-fifths of the maximum. Thus the rates of increase just before and of decrease after the optima times are not comparatively large, and the optima times can hardly be considered critical.

Although additional research will probably bring improvements in the process, the available data on the alkali digestion of salmon waste warrants serious consideration by the industry. With 1.5 parts of sodium hydroxide per 100 parts of waste the digestion at 200° F. was comparatively simple and easy to control. The equipment and manpower costs would be reasonable, and the product would be of good quality. From a canning line packing 200 cases of canned salmon per hour, about 5,000 pounds of waste per hour would be recoverable. As approximately 75 minutes would be sufficient time for each batch operation, digestion and settling tanks with a total capacity of 3,000 gallons would be adequate to handle the waste. As only the top oil-rich layer would need be handled, a 200-

to 400-gallon-per-hour centrifuge would generally be sufficient. If the equipment were arranged efficiently, not over two men would be required to handle the operations. At the oil recovery rate found in this study, the process would convert 5,000 pounds of troublesome pink-salmon waste into 300 pounds of salable oil per hour.

LITERATURE CITED

ANDERSON, LYLE
1945. A PRELIMINARY REPORT ON AN ALKALI PROCESS FOR THE MANUFACTURE OF COMMERCIAL OIL FROM SALMON CANNERY TRIMMINGS. FISHERY MARKET NEWS, VOL. 7, NO. 4, PP. 4-7.

BUTLER, CHARLES; AND MIYAUCHI, DAVID
1947. THE PREPARATION OF VITAMIN OILS FROM SALMON CANNERY OFFAL BY THE ALKALI DIGESTION PROCESS. DEPT. OF COMMERCE, INDUSTRIAL RESEARCH AND DEVELOPMENT DIVISION, CONTRACT CAC-47-17 REPORT, PART 1, PP. 52-70.

CARLSON, CLARENCE J.; AND MAGNUSSON, HARRIS W.
1948. PROCESSING SALMON CANNERY WASTE FOR RECOVERY OF VITAMIN A OILS. IBID., PART II, PP. 63-75.

STANSBY, MAURICE E.; AND LEMON, JAMES M.
1937. QUANTITATIVE DETERMINATION OF OIL IN FISH FLESH. INDUSTRIAL AND ENGINEERING CHEMISTRY (ANAL. ED.), VOL. 9, PP. 341-343.

VOTH, MENNO D.
1946. REPORT OF ETHER EXTRACT IN FISH. ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, VOL. 29, PP. 46-47.

--R. N. Ten Eyck,* H. W. Magnusson,** and J. E. Bjork.*

* TECHNOLOGIST AND CHEMIST, RESPECTIVELY, FORMERLY WITH THE FISHERIES EXPERIMENTAL COMMISSION OF ALASKA.
** CHEMIST, BRANCH OF COMMERCIAL FISHERIES, U. S. FISH AND WILDLIFE SERVICE.

ALL STATIONED AT FISHERY PRODUCTS LABORATORY, KETCHIKAN, ALASKA.

FISH PROCESSING HANDBOOK FOR THE PHILIPPINES

Fish is second only to rice as a food in the Philippines. This handbook, intended for both home and commercial processors of Philippine fishes, covers the handling of fresh fish, the various methods of preserving fish--freezing, salting, drying, smoking, canning, and miscellaneous methods such as pickling--and the spoilage of fish and fish products. It gives a step-by-step description of Philippine fish-preserving methods with suggestions on improving them, and of methods used in other parts of the world which have been adapted for Philippine use by the Philippine Fishery Program of the U. S. Fish and Wildlife Service. Tables of useful data for fish processors and of drawings of common species of Philippine fish are included.

By Arthur C. Avery. Research Report No. 26. Fish and Wildlife Service, Washington, D. C. (1950), 149 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 50 cents.

TECHNICAL NOTE NO. 15--CONDUCTING ORGANOLEPTIC TESTS IN THE LABORATORY

Organoleptic tests are frequently employed in fishery technological research, particularly where the quality of two or more lots of fish are compared. In most cases, no reliable chemical or objective test is available; also, existing chemical tests may not be applicable to the particular problem. Quite often only small differences in quality of the fish may exist. Therefore, unless the reproducibility of the results of organoleptic tests is high, small differences in quality between lots of fish may not be detected.

Observations made by an organoleptic testing panel are apt to be highly erratic. For example, if two identical lots of fish are examined, some members of the testing panel are almost certain to report a difference even though none exists. It is the objective of every well-planned organoleptic test to eliminate the guesses so that the data represent actual values of the samples examined. Otherwise, the good data are so "diluted" with irrelevant opinions that it is impossible to detect fine differences, if any, between samples.

At the Seattle Fishery Technological Laboratory many different methods of conducting organoleptic tests have been tried. No method has proved universally applicable or has given entirely satisfactory results for any particular problem. Attempts are continually being made to improve our technics. Nevertheless, considerable experience in conducting organoleptic tests has been acquired over a period of about 15 years even though no final procedure can be recommended.

Where greatest accuracy is required in detecting small differences in quality, a preliminary test is conducted to determine whether each member of the proposed panel can distinguish between the two samples. This preliminary test is carried out as follows:

The individual is blindfolded or placed in such a position where he cannot see the samples. He is then given a portion of the first test sample which is identified to him as sample A. The same is done with the second sample, which is identified to the tester as sample B. He is then allowed to taste or examine each sample until he feels reasonably certain he can distinguish between the two. He is then given samples of A and B in some mixed order such as A - B - B - B - A - A, etc., without identification. The tester must identify at least 5 out of 6 or 7 out of 9 samples to be qualified--all other testers are disqualified. Only the qualified testers are instructed to complete the rating or score sheets for the products.

The following are some important precautions which we have found necessary or desirable in carrying out organoleptic tests. These are followed carefully and the factors involved are controlled as far as possible in order to obtain greatest accuracy of organoleptic examinations.

1. Elimination of bias: Observers must not be allowed to comment on their ratings or discuss identity of samples in the presence of other observers who have not finished their test.

2. Irrelevant distinguishing characteristics of samples: In some cases, two samples can be differentiated by means of some characteristic other than those being tested for. For example, we have sometimes used as controls samples of fish frozen in round tin cans and sometimes such samples are deformed by the shape of

the can so that observers know which is the control. In other cases, a chemical dip may have discolored one sample. In still other cases where judgment of flavor only is desired, the texture of the samples being compared may be so different that results are really correlated with texture not flavor.

3. Homogeneity of samples: Most pieces of fish differ in appearance, flavor, odor, and texture from one part of the piece to another. In many instances there is greater difference between parts of the same piece than between samples. This is a very difficult problem to deal with. When flavor only is of interest, we have sometimes "homogenized" each sample in a Waring Blendor. In other cases it may be necessary to take great care to compare pieces from comparable portions of the fish. This is particularly a problem with fish which have oil deposits beneath the skin or with fish which have pronounced streaks of dark flesh just beneath the skin along the lateral line.

4. Temperature differences of samples: Samples to be compared should be at the same temperature. Odor and flavor of fish are markedly a function of temperature. If we try to compare a fish which has just finished thawing, or has just been removed from ice, with one at room temperature, erroneous results will be obtained because of the lowered volatility of odors from the fish at the lower temperature.

5. Method of cooking: When cooked samples are to be compared, there is always the danger that differences in cooking or seasoning between the samples will obscure the differences being looked for. We always add salt by dipping the samples in a salt solution (1 tablespoon per cup of water) for periods of time up to 5 minutes, depending on thickness of samples, and then draining. The samples are cooked in either of two ways: (1) they are wrapped in parchment paper and placed in simmering water or (2) baked in an oven. The former gives probably the most uniform cooking but often results in a bland product, quite different from what one would eat under normal conditions. Hence, we often use the baking method.

6. Number of samples to be compared: It is best to compare directly only two samples. Organoleptic tests are so uncertain that even when only two samples are compared, it is hard to get good results. If three or more samples are compared the observer is apt to become confused unless there are considerable differences among the samples.

7. Number of tests per day: As a general rule, we find it best to limit the testing by one person to one pair of samples in the morning and another pair in the afternoon. A few persons can successfully compare a larger number of samples. It is not possible to spend a complete day in comparing flavor of fish. After a relatively short period of time, the sense of taste becomes blunted and the sense of discrimination of the tester declines to the point where it is not feasible to continue.

8. Removing flavors from mouth: It is desirable to provide some means of removal of the flavor of the first sample before testing the next one, especially in instances where one or both of the samples being compared have a rancid or other strong flavor. We have found, after trying various things, that sipping a small amount of apple juice between samplings is helpful.

9. Use of score sheets: Use of score sheets or rating forms indicate clearly the information desired and facilitates recording of data. In order to carry out organoleptic tests, it is usually necessary to solicit assistance from persons on other projects and to ask them to give up time from their regular work. The score sheets should be set up for convenient use and, if possible, require merely

checking of appropriate items. The forms should be as complete as possible before being submitted to the panel members and may have already the member's name, date, and other pertinent information filled in.

10. Advance arrangement of time for tests: It is desirable to make advance "appointments" with members of the panel. This allows the members to arrange their own work in advance so that they can participate in and allow more time for the organoleptic tests. It may even make it possible to obtain additional prospective testers. One important cause of inaccurate observations is that panel members are in a hurry to return to their own work and hence do not devote enough careful attention to the organoleptic testing.

11. Education of organoleptic-panel members: Panel members should understand the meaning of terms used in the score sheets. Do they know what is meant by such terms as "stale," "rancid," etc.? Do all members indicate the same evaluation by the grades assigned to samples? Furthermore, in order to keep up interest in the work, we have found it necessary to hold occasional meetings of persons participating in such tests. These meetings are held at various stages of the work. A preliminary meeting might be held early in the work explaining the purpose of the project and defining terms. Subsequent meetings would discuss results obtained and might identify samples which in the actual tests were designated by code numbers. Such meetings serve to educate and train panel members for the project in question and tend to create an active interest in the work.

12. Time after smoking: Use of tobacco probably blunts the sense of taste. We suggest that panel members refrain from smoking for at least one hour prior to the organoleptic tests. Of course, no smoking is allowed in the judging room.

13. Restriction of information requested of the panel to that urgently needed: The data requested of the panel should be limited to only those factors pertinent to the test. If information on texture is all that is required, the panel should not be requested to give flavor, odor, and appearance ratings. Furthermore, the score sheet should list only those factors to be considered. We make up new score sheets for almost every new project and often use several different sheets for different phases of a given project.

Even with all these precautions, results are never as good as we would desire. We are continually trying new technics in an effort to improve on the reproducibility of our results.

--M. E. Stansby, Chief,
Pacific Coast and
Alaska Technological Research,
Fishery Technological Laboratory,
Seattle, Washington

RECENT TECHNOLOGICAL PUBLICATIONS

COMMERCIAL FISHERIES REVIEW Articles and Separates:

The following technological articles appeared in Commercial Fisheries Review and were also issued as separates. Both the issue in which each article appeared and the number of the separate which was issued after the article was published in the Review are given below.

Salmon Cannery Trimmings: Part I - Relative Amounts of Separated Parts, by H. W. Magnusson and W. H. Hagevig, vol. 12, no. 9 (Sept. 1950), pp. 9-12 (Sep. 258).

Studies on Analytical Methods of Extracting Vitamin A and Oil from Fishery Products: Part III - Experiments on the Extraction of Low Oil Content Livers with Petroleum Ether by the Shaking Method, by F. Bruce Sanford and Neva L. Karrick, vol. 12, no. 6 (June 1950), pp. 4-8 (Sep. 254).

Utilization of Salmon Eggs for Production of Cholesterol, Lipide, and Protein, by G. I. Jones, Edward J. Carrigan, and John A. Dassow, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 8-14 (Sep. 262).

Studies on Analytical Methods of Extracting Vitamin A and Oil from Fishery Products: Part IV - Experiments on the Extraction of Low Oil Content Livers with Acetone, Ethyl Ether, and Petroleum Ether, by F. Bruce Sanford and Wm. Clegg, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 18-20 (Sep. 264).

A Chemical Evaluation of Tuna Liver and Beef Liver Meals Prepared by Different Methods, by G. I. Jones and Wm. Hoyer, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 21-7 (Sep. 265).

Vitamin A Potencies of Liver Oils of Bering Sea Cod and Flounder, by F. Bruce Sanford, John A. Dassow, and E. F. Dietrich, Technical Note No. 6, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 29-30 (Sep. 267).

Processing Canned King Crab Meat, by M. E. Stansby, Technical Note No. 8, vol. 13, no. 2 (Feb. 1951), pp. 29-30 (Sep. 275).

Characteristics of Oil from Cold-Rendered Fur-Seal Blubber, by Wm. Clegg, Technical Note No. 9, vol. 13, no. 2 (Feb. 1951) pp. 30-1.

Paper Bags for Fish Meal, by G. M. Pigott, Technical Note No. 10, vol. 13, no. 3 (Mar. 1951), pp. 13-4 (Sep. 276).

Use of Frozen Salmon for Canning, by M. E. Stansby and John Dassow, vol. 13, no. 4 (Apr. 1951), pp. 20-5 (Sep. 279).

"Pink Yeast" Isolated from Oysters Grows at Temperatures Below Freezing, by Grace McCormack, Technical Note No. 5, vol. 12, no. 11a (Nov. 1950 - Supplement), p. 28 (Sep. 266).

Feeding Studies with the Gum of Gracillaria confervoides and Carboxymethylcellulose, by Hugo W. Nilson and Maurice Bender, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 15-7 (Sep. 263).

Feeding Value of Fish Meals, by Hugo W. Nilson, vol. 12, no. 12 (Dec. 1950), pp. 8-11 (Sep. 269).

Results of Some Tests with Frozen Lobsters and Lobster Meat, by S. R. Pottinger, vol. 12, no. 11a (Nov. 1950 - Supplement), pp. 31-3 (Sep. 268).

Effect of Fluctuating Storage Temperature on Quality of Frozen Fish Fillets, by S. R. Pottinger, vol. 13, no. 2 (Feb. 1951), pp. 19-27 (Sep. 272).

Control of Fish Spoilage by Icing and Freezing, by Harold E. Crowther, vol. 13, no. 3 (Mar. 1951), pp. 6-10 (Sep. 274).

Fishery Products as a Source of Animal Protein, by Hugo W. Nilson, vol. 13, no. 5 (May 1951), pp. 6-9 (Sep. 282).

Special Scientific Report: Fisheries:

Seasonal Variations in Toxicity of Butter Clams from Selected Alaska Beaches, by John S. Chambers and Harris W. Magnusson, Report No. 53 (Aug. 1950).

Research Report:

Curing of Fishery Products, by N. D. Jarvis, Report No. 18 (1950).

Articles by Fish and Wildlife Service Authors in Outside Publications:

The Amazing Fish Meal Industry, by F. Bruce Sanford. Presented at the National Fisheries Institute Annual Convention (1951) and reproduced by N.F.I. for distribution to its members.

Fish Liver Oils, by F. Bruce Sanford. Published in the Encyclopedia of Chemical Technology, vol. 6 (1951).

Fish and Shellfish, by M. E. Stansby. Published in the Encyclopedia of Chemical Technology, vol. 6 (1951).

An Improved Method of Glazing Fish for Locker Storage, by S. R. Pottinger. Published in Quick Frozen Foods (Nov. 1950), also Fishery Leaflet 321.

Feeding Tests with Some Algin Products, by Hugo W. Nilson and John A. Wagner, Proceedings of the Society for Experimental Biology and Medicine, vol. 76, pp. 630-5 (1951).

Miscellaneous Reports or Outside Publications:

Marine Products of Commerce, by D. K. Tressler and J. McW. Lemon, Reinhold Publishing Corp., New York, N. Y. (1951).

Official Report of the Delegation of the United States of America to the Food and Agriculture Organization Meetings at Bergen, Norway (1950). Part I - Meeting on Herring Technology, Part II - Meeting on Fisheries Technologists, by H. E. Crowther.

FREEZING FISH AT SEA--NEW ENGLAND

The following reports on the project "Freezing Fish at Sea, Defrosting, Filleting, and Refreezing the Fillets," will appear in the February 1952 issue of Commercial Fisheries Review.

FREEZING FISH AT SEA - NEW ENGLAND

PART 1 - PRELIMINARY EXPERIMENTS, BY J. C. HARTSHORNE AND J. F. PUNCOCHAR

Fillets from round-frozen thawed fish are compared with fillets from iced fish as to percent drip, salt content, trimethylamine content, keeping quality, and yield.

* * *

PART 2 - EXPERIMENTAL PROCEDURES AND EQUIPMENT, BY H. W. MAGNUSSON, S. R. POTTINGER, AND J. C. HARTSHORNE

In view of the favorable results of the preliminary tests on freezing-fish-at-sea, further laboratory and pilot-plant studies were carried out to secure data in preparation for a commercial-scale investigation. For freezing fish at sea aboard the Service's experimental trawler Delaware, the method of freezing fish by immersion in cold brine was adopted for the initial tests. Salt penetration into the fish meat does not seem to be a serious problem. Thawing the frozen whole fish in water (so that they can be filleted) seems to be the most practical method. Organoleptic, physical, and chemical test procedures for judging the quality of the frozen fillets are described.

* * *

PART 3 - THE EXPERIMENTAL TRAWLER DELAWARE AND SHORE FACILITIES, BY C. BUTLER, J. F. PUNCOCHAR, AND B. O. KNAKE.

A description of the experimental trawler Delaware is presented, including the general characteristics of the vessel, alteration of the fish hold, and the refrigeration system. Also described are the shore facilities, which consist of the pier for moorage of the vessel; a pilot plant; a laboratory; and offices. Operation of the vessel and freezing facilities, and handling of the fish ashore are discussed.

* * *

PART 4 - COMMERCIAL PROCESSING OF BRINE FROZEN FISH, BY C. BUTLER AND H. W. MAGNUSSON

Results are presented of the first semicommercial scale processing of round brine-frozen scrod haddock under normal fillet-plant operating conditions.

Technological Associate Editors for this Issue:

H. E. Crowther F. T. Piskur

* * * * *

Illustrator--Gustaf T. Sundstrom
Compositors--Jean Zalevsky, Dorothy Stein, Alice Walish

* * * * *

Photograph credits: Page by page, the following list gives the source or photographer for each photograph in this issue. Photographs on pages not mentioned were obtained from the Service's file and the photographers are unknown.

P. 1--J. F. Puncochar; p. 7 and 40--N. B. Wigutoff; pp. 27, 28 29, 30, 32, and 33--R. G. Landgraf, Jr.

INT.-DUP. SEC., WASH., D.C. 13157

TECHNOLOGICAL SECTION ORGANIZATION CHART

Branch of Commercial Fisheries, U. S. Fish and Wildlife Service
Department of the Interior

Washington, D. C.

Name	Title	Room Number	Telephone
Harold E. Crowther	Chief, Technological Section	3352	Republic 1820
Frank T. Piskur	Asst. Chief, " "	3350	Ext. 4745

Field Activities

Fishery Refrigeration

Name	Title	Address	Telephone
James M. Lemon	Technologist	Fishery Technological Laboratory P. O. Box 128 College Park, Md.	Warfield 5800

Laboratories

Location	Address	In Charge	Telephone
East Boston 28, Mass.	Fishery Technological Laboratory Lockwood Basin 61 Sumner Street	Joseph F. Puncochar, Chief, North Atlantic Technological Research	East Boston 7-4307
College Park, Md.	Fishery Technological Laboratory P. O. Box 128	Hugo W. Nilson, Pharmacologist in Charge	Warfield 5800
Ketchikan, Alaska	Fishery Products Laboratory Box 647	John A. Dassow, Chief, Fishery Products Laboratory	Ketchikan 540
Seattle 2, Wash.	Fishery Technological Laboratory 2725 Montlake Boulevard	Maurice E. Stansby, Chief, Pacific Coast and Alaska Technological Research	East 0586